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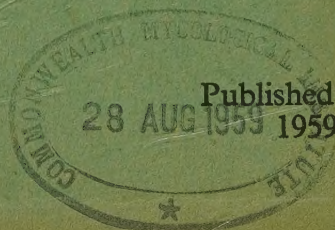
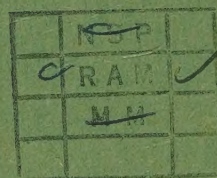
1958/9

COFFEE RESEARCH STATION, RUIRU

AND

COFFEE RESEARCH SERVICES
KENYA

Price: Shs. 25.00



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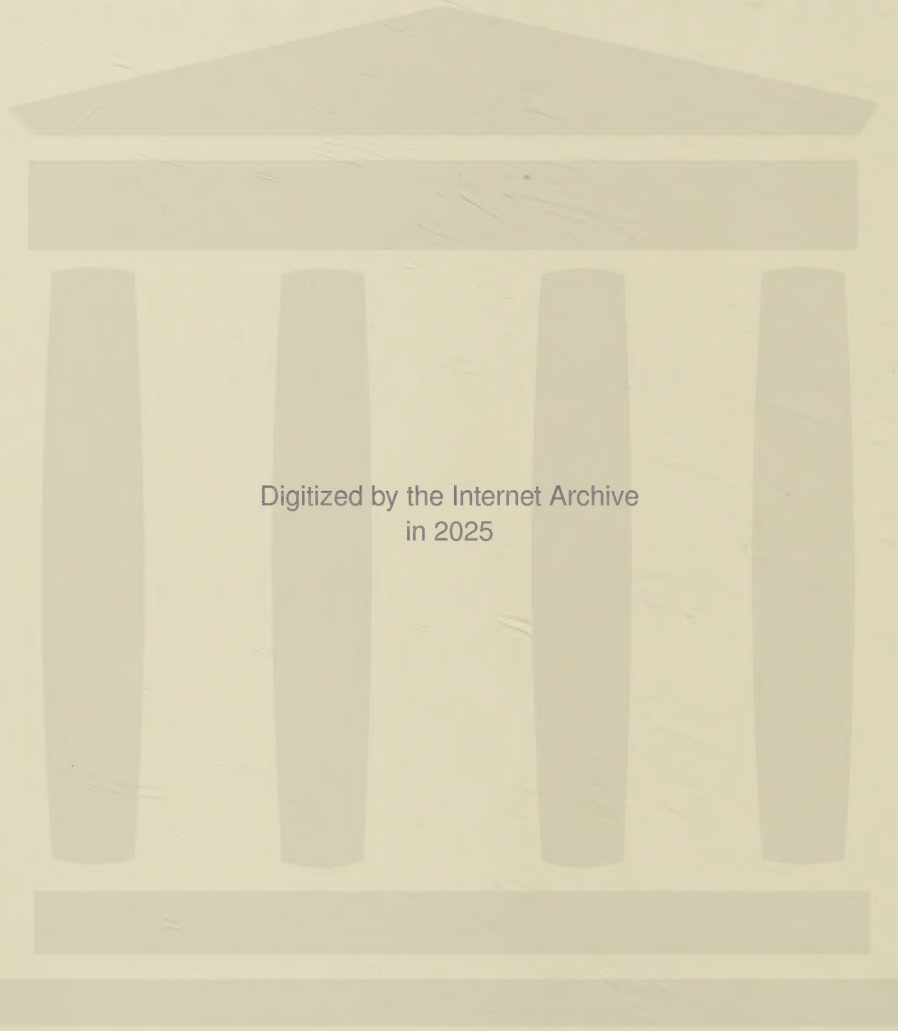
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Published July
1959



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INTRODUCTION

For the fourth successive year heavy rainfall was experienced during the dry season prior to the Long Rains (March-June). After abnormal showers in January heavy rainfall was recorded throughout the coffee areas in February. As in the previous year, these conditions favoured a rapid recovery from the effects of crop strain, but engendered a build-up of leaf rust infection prior to the Long Rains. As in the previous year, the consequence was that rust attained epidemic levels in all districts East and West of the Rift in the latter half of the year while the crop was maturing on the tree. In the East Rift districts in particular defoliation was severe due to rust and to widespread attacks of leaf miners in most districts. Although good rain in July served to alleviate the effects of defoliation to some degree, the rainfall during the second half of the year was well below average except in Makuyu and Trans Nzoia districts.

The general effect of these conditions upon the crop was not universally favourable. Yields were heavier than normal in some districts, Upper Kiambu, Rift Valley and the Trans Nzoia especially. It was fortunate that ripening everywhere was abnormally early, lessening the consequences of defoliation and drought in the latter months of the year. With a few exceptions the level of quality showed a district improvement over the previous year, attributable mainly to the earliness of the crop.

Unlike the previous year, however, coffee berry disease infection declined generally during the latter half of the year, an effect attributable to dry weather and the widespread use of fungicidal sprays in the zones normally subject to the disease.

Rainfall at the Department's Coffee Stations during 1958 (inches)

	A	B	C	D	E
January	2.23	1.45	1.98	3.10	2.68
February	9.41	6.04	2.34	5.49	6.04
March	4.44	1.34	3.40	4.83	7.99
April	7.63	2.33	15.69	2.26	11.22
May	17.91	13.07	14.01	5.49	9.63
June	2.29	1.43	0.65	12.10	7.39
July	4.13	4.07	1.38	4.20	4.47
August	0.02	0.05	0.00	8.56	6.67
September	0.18	0.03	0.25	4.76	6.91
October	0.98	0.64	2.59	3.94	9.40
November	3.05	2.67	7.54	0.79	2.61
December	2.86	3.02	2.78	1.83	5.32
Total	55.13	36.14	52.61	57.35	80.33
No. of days Total	130	94	107	140	174
Means and No. of years	39.43 14	36.72 33	37.52 19	45.57 25	75.37 14

- A = Coffee Research Station, Ruiru.
- B = Scott Agricultural Laboratories, Kabete.
- C = North Kitito Estate, Makuyu.
- D = Kitale Experimental Station.
- E = Experimental Farm, Kisii.

Records from the new stations at Mariene, Meru and Yara Estate, Upper Kiambu, are incomplete.

A Plant Physiologist and Plant Pathologist to fill the vacancies listed have been appointed and are expected to arrive in April and August, 1959, respectively. Other posts vacant in March, 1959, were an Assistant Agricultural Officer (Field Investigations) and two Laboratory Technologists.

There were several changes of staff during the year: Mr. R. W. Rayner retired at the end of 1958; Mr. D. J. McCrae transferred in May and was replaced by Mr. T. J. Crowe in September; Mr. Toomey transferred from Field Services to the Koru Substation; Mr. Reynolds was transferred to the post vacated by Mr. Radford; Mr. D'Olier resigned in July. New appointments made during the year were: Messrs. Beachman, Gough, Leviser, Mwae and Mrs. Brown.

Research into the problems of artificial drying of parchment coffee was continued as a special project by Mr. J. F. McCloy of the East African Industrial Research Organization. Full reports were issued periodically throughout the year by the E.A.I.R.O. and an extract from Mr. McCloy's annual report appears elsewhere in this volume. Soon after his appointment in December Mr. Gough was seconded to assist in the processing investigations.

Depredation of insect pests continued to cause concern to the industry, tip stem borer and leaf miners particularly. Much of the Entomologist's attention was directed towards acquiring a better understanding of both pests and improved methods of chemical control of leaf miners were developed. Since lacebug is now attaining outbreak levels generally in the West Rift annually and spreading northwards East of the Rift, it is fortunate that an easy and effective control measure is available in the use of malathion sprays.

The study of leaf rust and its control was limited by the absence of the Plant Pathologist on sick leave for most of the year. As a result of the investigations carried out at the Coffee Rust Investigation Centre in Portugal, supported by local studies conducted at Ruiru, a clear picture has now emerged of the reaction of resistant strains of coffee to the rust races locally endemic and the distribution of the latter is becoming clearly defined. Confirmation of these conclusions will be required and the Rust Exposure Trials sited in the main coffee-growing districts are designed for this purpose. As reported elsewhere in this volume, observations made to date in trials in African districts support the reaction pattern postulated by Dr. d'Oliveira in Portugal.

During the five years since the Airblast spraying technique was introduced the method has been adopted into normal estate practice. Trials to assess the response to tonic copper sprays when applied by Airblast methods have shown the value of higher concentrations of copper fungicide in obtaining full yield response with lower volumes of water. This differs from previous conclusions in that trials operated with hand lances have not hitherto generally indicated the need for concentrations higher than 1 lb. of 50% copper fungicide per 15 gallons of water.

In Agricultural Chemistry the emphasis of Mr. Robinson's work has shifted from nitrogen to a detailed examination of the circumstances which give rise to the magnesium deficiency syndrome in the tree. Good progress in elucidating the problem was made during the year. In particular, attention was devoted to employing mulch grass species with low potash contents and to assessing the effects of magnesium fertilizer dressings on the tree and crop in conjunction with grass mulching as a routine practice.

The total quantity of coffee seed issued during the season again shows a substantial increase over the previous year. 5,215 lb. were issued to European plantations, 5,504 lb. to African districts and 69 lb. to other territories, making a total of 10,788 lb. of seed.

After much initial delay the programme for expanding coffee research was put in hand during the year: a new substation was opened in Upper Kiambu and some of the additional laboratory staff entailed in the programme were appointed. With the inception in December of one further new station at Koru in Nyanza and financed directly by the Coffee Board, the total number of substations becomes five plus two minor stations. This represents a good coverage for the diverse conditions prevailing in the coffee areas of the Colony.

ADVISORY AND EXTENSION SERVICES

Over the past ten years our ability to provide an advisory and extension service worthy of the name has steadily increased as the staff position improved. In the past year addition to our resources provided by the Expansion Programme has allowed this side of our activities to be stepped up to a level approaching the optimum. There has been an encouraging increase in the number of advisory visits to estates, advisory tours, enquiries by letter and telephone and in the number of visitors to the station seeking advice.

The various ways by which information and advice has been passed to growers is illustrated by the following:—

General Advisory Service. Mr. Cottington visited some 350 estates during the course of the year, including three tours of Nyeri and three of the coffee districts of the Rift Valley. West of the Rift, Mr. de Vink, in addition to his routine advisory duties in the Trans Nzoia and Uasin Gishu districts, undertook three advisory tours in Nyanza before Mr. Toomey took over in August. The Upper Kiambu and Limuru districts have been served by Mr. Goodwin since his return from leave in November. Advice on specialized subjects was augmented as described later in this report, whilst requests to the Pathology section for assessment of the performance of sprayers, by evaluating the copper deposit on leaf samples, have grown to a routine service. The Irrigation Advisory Service has been operating for the past two years and could, with advantage, be more widely used by estates in the East of Rift districts.

Tours. District tours during the period under review included: Mr. Jones to the Trans Nzoia in June and March, Nyanza and Solai; policy surveys in Kiambu, Elgon Nyanza (twice), South Nyanza, Meru and Marsabit; Mr. Robinson to the Trans Nzoia (twice), Nandi, Fort Ternan and Koru; Mr. Crowe to Nyeri in March.

Field Days. A group of Nyeri planters was welcomed to a Field Day on the two estates in June. Messrs. Robinson and Wallis participated in the Tanganyika Coffee Growers' Association Planters' Day in July, and Mr. Cottington gave a discourse to the K.N.F.U. Farmers' Day gathering at Fort Ternan. A public demonstration of machinery for harvesting mulch grasses, held at the Station in July, was well attended.

Lectures. On several occasions officers were called upon to discourse to district group meetings in Thika, Kiambu and Trans Nzoia districts. Messrs. Jones and Robinson delivered the annual coffee lectures to students at the Egerton Agricultural College.

Courses. Apart from Mr. Hanger's advisory activities, numerous courses were held for African Coffee Instructors. Messrs. Hanger, Robinson and Crowe delivered lectures to courses for Coffee Officers at Nyeri and Embu.

Shows. Exhibits were staged at the R.A.S.K. Shows, at Mitchell Park in October, by Mr. de Vink at Kitale in December and the Western Kenya Show in February.

Rukera Demonstration Farm. Visitors have made more use of the opportunity to study the farming policy on Rukera, particularly those new to coffee and those whose purpose was a "short course" on the Station. The financial aspects of the farm constitute an essential feature of its function. Full details of the accounts appear later in this volume.

Publications. The outstanding feature in this sphere was the issue of separate annual reports, containing a comprehensive account of the year's research results. The first separate report, for 1956/7, was published in September and the second report, for 1957/8, came out in January. For the first time a full account of the research programme and the conclusions accruing therefrom are accessible to those who are interested in Kenya and elsewhere. The Bibliography of Technical Articles published in the *Coffee Board Bulletin*, which was first produced in 1952, was brought up to date and published in a revised form in April, under the title "Selected Articles on Coffee Culture". A copy of this book was sent to all licensed plantations and Coffee Co-operatives. The "Better Coffee Farming" notes in the Monthly Bulletin were maintained as a means of disseminating advice and information to the industry.

PUBLICATIONS

The following articles were published in the Monthly Bulletin of the Coffee Board of Kenya:—

VOL. XXIII

- April** "Notes on a Tour of Nyanza Coffee Districts," by P. A. Jones and J. B. D. Robinson.
 "Airspraying against Antestia and Lacebug in Coffee," by D. J. McCrae.
- May** Annual Report for Coffee Team Services, by P. A. Jones.
- June** "Control of Coffee Lacebug," by D. J. McCrae.
- July** "Fertilizing Coffee Seedlings," by J. B. D. Robinson.
- September** "Report on a Short Visit to the Kivu Arabica Coffee Area of the Belgian Congo," Part I, by D. J. McCrae, J. B. D. Robinson and J. A. N. Wallis.
- October** "Report on a Short Visit to the Kivu Arabica Coffee Area of the Belgian Congo," Part II, by D. J. McCrae, J. B. D. Robinson and J. A. N. Wallis.
- November** "Coffee Seed Issued by the Coffee Research Services," by J. A. N. Wallis.

VOL. XXIV Renamed "Kenya Coffee".

- January** "A Control of Chronic Iron Deficiency in Coffee (*Coffea arabica*) growing on localised hut or cattle boma sites," by J. B. D. Robinson.

"Selected Articles on Coffee Culture." A Bibliography and Selected Articles from the Coffee Board of Kenya Monthly Bulletin. Edited by P. A. Jones. Pp. XXIV+185. Published by the Coffee Board of Kenya and Coffee Research Station in April, 1958. Price: Shs. 25/-.

Articles published in other journals during the year were as follows:—

- Robinson, J. B. D., and Chenery, E. M. Magnesium Deficiency in coffee with special reference to mulching. *Emp. J. Exp. Agric.*, 1958, **28**, 259.
- Robinson, J. B. D. Chemical weed control in Coffee. Contribution to "Advances in Coffee Production Technology," Coffee and Tea Industries and the Flavour Field, 1958, Nov., 100.
- Bock, K. R., Robinson, J. B. D., and Chamberlain, G. T. Zinc deficiency induced by mercury in *Coffea arabica*. *Nature (Lond.)*, 1958, **182**, 1607.
- Robinson, J. B. D., Evans, H. R., and Brook, T. R. Camber Bed cultivation of ground water (Vlei) soils. Pt. I. Experimental Crop Yields. *E. Afr. agric. J.*, 1959, **24**, 184.
- Brook, T. R., and Robinson, J. B. D. Camber Bed cultivation of ground water (Vlei) soils. Pt. II. Modification of the system. *E. Afr. agric. J.*, 1959, **24**, 192.
- Wallis, J. A. N. Herbicides in Kenya Coffee (Parts I—III). Pesticides Abstracts and News Summary, Section C. **4**, 146.
- Crowe, T. J. Empire Cotton Growing Corporation. Progress Reports from Experiment Stations (Kenya 1956/7).
- Hanger, B. F. Notes on Kenya Agriculture—V. Plantation Crops—Arabica Coffee. *E. Afr. agric. J.*, 1959, **24**, 153.

FIELD INVESTIGATIONS

CULTIVATION TRIAL

In 1958 the yields recorded from this trial were exceptionally low and there was no significant difference between any of the treatments.

The mean yield for the whole experiment was 0.74 cwt. clean coffee per acre and was carried on young suckers which appeared to have grown well in the pruning conversion year of 1957, during which the two remaining old heads on each tree carried coffee at a mean rate of 11.66 cwt. of clean coffee per acre. It is considered that too heavy a crop was produced in 1957 which, though it did not noticeably reduce the sucker growth, so depleted the carbohydrate reserves of the coffee trees that no reasonable crop could be produced in 1958.

ROTAVATOR TRIAL

A satisfactory crop was harvested from this trial in 1958 (mean 11.13 cwt. clean coffee per acre) but there was no significant difference between treatments.

The mean annual yields for the five-year period 1954-1958 are shown in Table I.

TABLE I

Yield Summary 1954-1958
(Mean annual yields in cwt. clean coffee per acre)

<i>Implement</i>	<i>1954-1958</i>	<i>Level of Significance</i>
Rotavator	8.26	} Not significant
Forked Hand Hoe	7.85	
<i>Weeding</i>		
Clean weeding during the Rains	8.51	} Not significant
No weeding during the Rains	7.60	
<i>Mulch</i>		
With alternate inter-row mulch	8.88	} Significant
Without mulch	7.23	
		p = 0.05
Mean	8.06	
Coefficient of Variation %	13.96	
Least Significant Difference	1.33	

Only the mulch treatment has increased the yield of clean coffee significantly, for although in two of the five years weeding during the Rains has increased the yield substantially in the aggregate figures for the five years, this effect does not reach statistical significance. This unusual result is probably related to the exceptionally high rainfall in the years 1956-1958 and the fact that there are

only two absolute replications of the experimental treatments; so that although weeding has appeared to raise the mean annual yield of clean coffee by 0.91 cwt. per acre this result cannot be quoted with the degree of confidence desirable in agricultural experiments.

IRRIGATION TRIAL

Following the 1957 crop two old heads were removed from each tree so that the 1958 crop was borne on three young suckers per tree. The mean yield for the trial in 1958 was 2.13 cwt. of clean coffee per acre and there was no significant difference between treatments.

TABLE II
1958 Yields
(Yields in cwt. of clean coffee per acre)

	<i>Cwt.</i>
<i>Time of Irrigation</i>	
+ a In December	2.06
— a Not in December	2.19
+ b In May/June	2.25
— b Not in May/June	2.00
+ c In August	1.97
— c Not in August	2.28
<i>Method of Irrigation</i>	
O Overhead sprinkler	2.05
G Ground watering	2.20
<i>Nitrogenous Fertilizer</i>	
+ N 100 lb. Urea/acre	2.02
— N Nil	2.23
	<i>No Significant Difference</i>

MULCH TRIAL

In 1958 the crop was carried for the first time on the young suckers of a new cycle of multiple-stem pruning. On this trial the conversion from one cycle to another has been accomplished without a very serious loss in crop, viz.:—

<i>Years</i>	<i>State of the Pruning Cycle</i>	<i>Mean Yield per Acre</i>
1953-1956	3 Heads	12.60 cwt. clean coffee/acre
1957	2 Heads	7.60
1958	3 Young Heads of new cycle	6.47

Very distinct responses to mulch treatments are shown in the yields for 1958, when the all-inter-row pre-Rains applications increased the crop by 3 cwt. of clean coffee per acre.

TABLE III
MULCH TRIAL
Yield Summary 1958 and 1950-1958
(Mean annual yields in cwt. clean coffee per acre)

1958	Nitrogen Fertilizer at 46 lb. Nitrogen per Acre				Mean Yields for Mulch Treatments
	Nil	Ammonium Form	Nitrate Form	$\frac{1}{2}$ Ammonium $\frac{1}{2}$ Nitrate	
No mulch	4.88	4.79	4.69	4.81	4.79
All inter-rows pre-Rains—March	8.41	7.75	8.35	6.64	7.79
Alternate inter-row pre-Rains—March	6.02	7.17	7.38	5.68	6.56
All inter-rows post-Rains—July	7.10	7.54	6.25	6.04	6.73
Mean yields for Fertilizer Treatments	6.60	6.81	6.67	5.79	6.47
Least Significant Difference	Within the table			Between marginal means	
p = 0.05	2.26			1.13	
p = 0.01	3.05			1.53	
Coefficient of Variation	24.12%				
1950-1958 *					
No mulch	6.95	7.96	8.22	7.36	7.62
All inter-rows pre-Rains—March	9.05	8.87	9.28	9.03	9.06
Alternate inter-rows pre-Rains—March	8.11	9.11	9.17	8.18	8.64
All inter-rows post-Rains—July	8.68	9.03	8.55	9.09	8.84
Mean yields for Fertilizer Treatments	8.20	8.74	8.80	8.42	8.54
Least Significant Difference	Within the table			Between marginal means	
p = 0.05	1.26			0.63	
p = 0.01	1.71			0.86	
p = 0.001	2.27			1.14	
Coefficient of Variation	8.86%				

*Nitrogen Fertilizer per Annum } 1951-1953 23 lb. Nitrogen per Acre
1954-1958 46 lb. Nitrogen per Acre

Although no response to nitrogen fertilizer is evident in the 1958 yields or the overall mean figures for 1950-1958, it may be seen that, in the absence of any mulch, the nitrate fertilizer has increased the crop to an extent which just reaches statistical significance.

For the eight years 1950-1957 there was a cattle manure treatment in this trial, but no yield increase resulted from this treatment. It was discontinued after the 1957 application.

After the 1958 crop a pruning treatment was introduced into this trial which had hitherto been pruned uniformly. The two pruning treatments were allocated to plots made available by

discontinuing the cattle manure treatment and were so arranged that allowance could be made for any residual effect of the eight years of manure applications without upsetting the overall factorial design of the trial or altering the interactions which are confounded with blocks.

The pruning treatments are as follows:—

+C Cutting off primaries to an extent determined by examining the unmulched plots.

—C Cutting off primaries to an extent determined by examining the mulch plots. Following the 1958 crops, 3 ft. 6 in. of bearing wood was left on the +C plots and 4 ft. was left on the —C plots.

MANURIAL TRIAL I

Following the heavy yields recorded in 1957 (mean 23.28 cwt. clean coffee per acre) the crop in 1958 was very low (mean 1.40 cwt. clean coffee per acre). In neither of these years nor in the two mean yields, shown in Table IV, was there an overall significant effect of treatments (f test).

TABLE IV
MANURIAL TRIAL I
Yield Summary 1947-1958
(Mean annual yields in cwt. clean coffee per acre)

Period	lb. Nitrogen per Acre			4-gall. tins Manure per Tree			Mean	C. of V. %	Least Significant Difference	
1947-1956	Nil	23 As Sulphate of Ammonia	46	Nil	1	2			p=0.05	p=0.01
1957-1958	Nil	46 As Urea	46 As S/A	Nil	1	2				
1947-1951	4.44	4.47	4.75	4.66	4.52	4.48	4.55	12.32	0.25	0.33
1952-1956	7.38	7.83	8.34	7.75	7.71	8.09	7.85	3.47	0.27	0.38
1957-1958	11.68	12.04	13.27	12.07	11.79	13.13	12.33	9.95	"Not significant"	

It may be seen in Table IV that since 1957 both the nitrogen fertilizer treatments have supplied 46 lb. of nitrogen per acre, but either as sulphate of ammonia or as urea. However, neither form has increased the yield of coffee significantly during the two seasons 1957-1958.

MANURIAL TRIAL II

In 1950 this trial was initiated to test rates of fertilizer and cattle manure application twice as great as those already under investigation. From 1950-1956 the phosphate was applied as double superphosphate and the nitrogen as sulphate of ammonia; since 1957 basic slag has been applied at 642 lb./acre to supply the phosphate and 200 lb./acre of urea has been used to supply the nitrogen. Well-composted cattle manure has been produced on the Station to apply the treatments throughout the course of this trial.

TABLE V
MANURIAL TRIAL II
Yield Summary 1950-1958
(Mean annual yields in cwt. clean coffee per acre)

Annual Treatments		1950-1958	
Nitrogenous Fertilizer	Nil		7.98
	92 lb. Nitrogen/acre		9.34
	% response	+	17.04***
Phosphatic Fertilizer	Nil		8.79
	Equiv. to 2 cwt. double superphosphate/acre		8.54
	% response	—	2.84 N.S.
Cattle Manure	Nil		8.58
	4 × 4-gallon tins per tree		8.75
	% response	+	1.98 N.S.
C. of V. %			3.42
Least Significant Difference			
p = 0.05 *			0.35
p = 0.01 **			0.52
p = 0.001***			0.80

The nitrogen fertilizer treatment has produced useful increases in yields in six out of the nine years of this trial and has raised the mean annual yield by nearly 1½ cwt. of clean coffee per acre. In not one year has there been any response to the phosphate applications and only in 1957 did the cattle manure treatments increase the yield significantly. The negative interaction between nitrogen and cattle manure, which has previously been reported from this trial, remains evident; in the nine-year mean annual yields it is of the order of —0.40 cwt. of clean coffee per acre each year ($p=0.05$).

MANURIAL TRIAL III

This trial was laid down in 1952 to determine the best time to apply a nitrogen fertilizer at 46 lb. and 92 lb. nitrogen per acre. For the years 1952-1956 inclusive the nitrogen was applied in the form of sulphate of ammonia, but since 1957 urea has been used as the fertilizer.

TABLE VI
MANURIAL TRIAL III
Yield Summary 1953-1958
(Mean annual yields in cwt. clean coffee per acre)

Nitrogen per Acre per Year	Time of Application			Means
	Early in the Long Rains (April)	Early in the Short Rains (November)	A half early in Each Rains	
Nil	8.84	8.74	9.17	8.92
46 lb.	10.02	9.71	10.32	10.02
92 lb.	10.26	10.50	10.36	10.37
Means	9.71	9.65	9.95	9.77
C. of V. % 8.26	Within the table		Between marginal means	
Least Significant Difference				
p = 0.05	1.40		0.81	
p = 0.01			1.11	
p = 0.001			1.53	

Following the particularly high yields of 1957 (mean 21.90 cwt. clean coffee per acre) the crop in 1958 was very poor (mean 1.56 cwt. clean coffee per acre) and there was no significant difference between treatments. A summary of yield responses over the period 1953-1958 is given in Table VI. Both rates of fertilizer application have raised the yield by over 1 cwt. of clean coffee a year, but the high rate (92 lb. nitrogen per acre) has not been more effective than the lower (46 lb. nitrogen per acre). There has been no significant difference between the "times of application" treatments so that putting the fertilizer on in the Short Rains has been as effective as the Long Rains application.

MANURIAL TRIAL IV

In 1958 the crop was carried on two old heads per tree as one head had been removed following the 1957 picking season, in order to allow the strong development of a new set of suckers for the next pruning cycle. The mean yield for the trial in 1958 was 8.32 cwt. clean coffee per acre and in contrast with the previous season the mulch treatments raised the yields by as much as 197% while the nitrogen treatments failed to raise the yields at all.

TABLE VII
MANURIAL TRIAL IV
Yield Summary 1954-1958
(Mean annual yields in cwt. clean coffee per acre)

Lb. Nitrogen per Acre per Year	Mulch Treatments in March				Overall Means
	M_0	M_1	M_2	M_3	
	Nil	6 ft. between Alternate Rows	4½ ft. in Every Row	6 ft. between Every Row	
Nil	a 9.47	a 10.79	a 11.04	a 10.59	d 10.47
69	a 10.19	b 11.59	b 12.00	b 11.84	g 11.58
138	a 10.82	b 12.05	b 12.82	b 11.61	g 11.97
Overall Mean	c 10.16	e 11.61	e 12.13	e 11.50	11.48
Coefficient of Variation = 10.62% Least Significant Difference between	a & a b & b a & b c & c e & e d & g g & g			p = 0.05 2.02 1.43 1.75 1.04	p = 0.01 2.70 1.92 2.35 1.40
				0.90 0.76	1.20 1.03

TABLE VIII
THE EFFECTS OF FERTILIZER PLACEMENT ON THE RESPONSE TO NITROGEN
(Mean annual yields in cwt. clean coffee per acre)
(1954-1958)

Lb. Nitrogen per Acre per Year	Placement on Mulched Plots		Overall Mean of Mulched Plots
	Over the Bare Soil	On Top of the Mulch	
Nil			d 9.47
69	c 12.42	c 11.20	f 11.81
138	c 11.86	c 12.46	f 12.16
	f 12.14	f 11.83	
Least Significant Difference between	c & c d & f f & f c & d		p = 0.05 1.16 0.92 0.83 1.09
			p = 0.01 1.57 1.24 1.11 1.46

From the mean yields for the five-year period 1954-1958 which are summarized in Table VII it may be seen that all the mulch treatments have raised the mean yield of coffee significantly. Of the three degrees of mulching the intermediate treatment of a 4½-ft. strip in the coffee row has been the most effective though there is no significant difference between the yields from plots mulched in the various ways.

Both nitrogen fertilizer treatments have raised the yield of clean coffee significantly, but there is no significant difference between the annual application of 69 lb. of nitrogen per acre and the treatment in which nitrogen is applied at 138 lb. per acre each year. From Table VIII it appears that at the lower rate of fertilizer dressing the application to the bare soil is significantly better than the application over the mulch, but at the higher rate the fertilizer placement has not affected the yield results.

MANURIAL TRIAL VI

This trial was commenced in 1957 to compare two forms of magnesium fertilizer to supply a total of between 20 and 80 lb. of magnesium per acre each year. The first yields were recorded in 1958 when there was severe over-bearing throughout the trial. In early November, 1958, it was evident that the trees were incapable of ripening the crop still on the trees so it was all stripped off and treated as "mbuni". This stripping contributed 52% to the total fresh weight of cherry harvested from this trial in 1958. In Table IX the yields are estimated from 1/10th samples taken from each plot at each picking and thus include an allowance for clean coffee hulled from "mbuni".

There was no significant difference between treatment yields in 1958.

TABLE IX
MANURIAL TRIAL VI
1958 Yields
(Yields in cwt. clean coffee per acre)

lb. wt. of Fertilizer per Acre		KIESERITE			Mean
		Nil	112	224	
MAGNESITE	lb. wt. of Magnesium per Acre	Nil	18	36	
Nil	Nil	19.66	22.60	21.30	21.18
70	18	18.20	17.73	18.49	18.14
140	36	23.45	22.63	21.66	22.57
Mean		20.43	20.98	20.48	20.63
C. of V. %	18.29	No Differences Significant			

MANURIAL TRIAL VII

The effect on coffee yield of foliar sprays containing various concentrations of urea has been compared with urea applied around the base of each tree in a pelleted or prilled form. The high-volume sprays have been applied with a bucket pump and the low-volume sprays were put on with a "Micron Meg" sprayer in 1957 and with a "Motoblo" in 1958. After the 1958 treatments had been applied it was discovered that the urea used included over 7% biuret. This exceptionally high level of impurity led to a considerable amount of leaf scorch on the trees sprayed at a low volume but did not induce much leaf-fall. New leaves produced after spraying showed symptoms of biuret toxicity.

TABLE X
 UREA SPRAY TRIAL
 Yield Summary 1957-1958
 (Mean annual yields in cwt. clean coffee per acre)

lb. of Urea per Acre	Method of Application				Means
	Nil	Dry to the Ground	High Volume Foliar Spray	Low Volume Foliar Spray	
Nil	7.00 a				7.00 a
25			7.55 a	8.40 a	7.98 b
50		8.55 { 8.37 a	8.51 { 8.49 a	8.56 { 8.52 a	8.46 c
100		b { 8.73 a	b { 8.53 a	b { 8.59 a	8.62 c
200		9.77 a			9.77 a
Means	7.00 a	8.96 c	8.19 c	8.50 c	8.40
C. of V. % 15.24 Least Significant Difference between p = 0.05	a & a 2.19	b & b 1.55 a & b 1.90	a & c 1.79	b & c 1.42	c & c 1.27

In neither 1957 nor 1958 was the overall treatment effect statistically significant (f test), but a closer analysis of groups of treatments in Table X shows that generally all the fertilizer treatments have tended to increase the yield of coffee and that the method of application has not had much effect on the levels of response.

KITALE MULCH AND NITROGEN TRIAL VIII

In 1958 for the second year running there was no yield response to any of the treatments. Since the lack of response to urea was thought to be the effect of the heavy shade over the trial area all the shade trees were severely pruned in 1958. In 1959 it is proposed to increase the rate of urea application in treatments B and D to 200 lb. per acre a year. 100 lb. an acre will be applied early in May and 100 lb. an acre in August.

TABLE XI
 KITALE MULCH AND NITROGEN TRIAL VII
 Yield Summary 1957 and 1958
 (cwt. clean coffee per acre)
 (Derived by dividing the cherry yield by 6)

Treatment		1957	1958	2-year Totals
A.	Control	6.43	5.23	11.66
B.	Urea at 168 lb./acre—April	6.61	4.77	11.38
C.	Napier grass mulch—October	6.61	5.46	12.07
D.	Napier grass mulch October and urea at 168 lb./acre April	6.30	5.28	11.58
E.	Maize stover mulch—January	6.20	5.29	11.49
C. of V. %		27.29	26.52	
		No Significant Difference		

PRUNING TRIAL I

On the "multiple-stem" trees the 1958 crop was carried on the young suckers of the third pruning cycle since the trial began in 1946. The single-stem trees, which had yielded at the rate of over a ton of clean coffee to the acre in 1957, carried a light crop of about 5 cwt. per acre in 1958.

TABLE XII
PRUNING TRIAL
Yield Summary 1958 and 1946-1958
(Mean annual yields in cwt. clean coffee per acre)

Pruning System		1958	1946-1958
A.	"Multiple-Stem" 3 heads	4.63	7.19
B.	"Single-Stem" Capped once	4.56	7.94
C.	"Single-Stem" Capped thrice	5.67	7.59
D.	"Single-Stem" 2 stems	5.55	8.03
Mean		5.10	7.69
Co-efficient of Variation		35.27	6.88
No Significant Difference between treatments			

Neither in the yields for 1958 nor in the mean yields for the 13 years 1956-1958 can any significant difference be detected between treatments.

It has been shown that the multiple-stem trees produced a larger size bean (*Station Annual Report* 1956/7, page 33) and it is common experience that the pruning of a multiple-stem tree is simpler and quicker to carry out than the pruning of single-stem trees. For these reasons multiple-stem pruning is recommended on all mature coffee trees, though a pruning system suited to newly planted coffee is still under investigation.

MACHINE SPRAY TRIAL I

Two tractor-drawn sprayers have been compared for applying a copper spray every May to reduce leaf-fall in the subsequent three months. When the trial started in 1954 the Drake and Fletcher Quadrex "S" was selected as a high-volume sprayer to compare with the recently developed "Agro", of Ransomes, Sims and Jefferies, which used an airblast to assist the spray. The treatments, which were applied in each of the years 1954-1957 inclusive, are summarized in Table XIII.

TABLE XIII
MACHINE SPRAY TRIAL I
Yield Summary 1955-1958
(Mean annual yields in cwt. clean coffee per acre)

lb. of 50% Copper Formulation/100 galls.	Gallons per Acre	Sprayer	1955-1958
Nil	—	—	10.93
6.8	30	"Agro Airblast"	12.06
6.8	60	" " "	12.01
13.6	30	" " "	12.66
13.6	60	" " "	12.69
6.8	120	Quadrex "S"	13.01
C. of V. %			3.84
Least Significant Difference			
p = 0.05			0.71
p = 0.01			0.98
p = 0.001			1.35

There was no significant difference between treatment yields in 1958, but the mean annual yields for the four seasons 1955-1958 reveal a number of significant effects. All the spray treatments have succeeded in raising the mean annual yield by between 1 and 2 cwt. of clean coffee per acre. 120 gallons/acre applied with the Quadrex "S" produced a significantly greater yield increase than that recorded for the "Agro" treatments of 30 or 60 gallons per acre, provided that the same concentration of copper has been used. At the higher copper concentration there is no significant difference between the yields produced by the coffee sprayed with 30 or 60 gallons an acre from the "Agro" when compared with the Quadrex "S" sprayer applying 120 gallons an acre of the spray with the lower copper content.

MACHINE SPRAY TRIAL II

In this trial two air-assisted sprayers are compared as machines to apply a copper spray to reduce premature leaf-fall and thus to increase the subsequent yield of coffee. The first treatments were applied in May, 1956, and the first crop was recorded in 1957: yields were low and no treatment had any apparent effect on the weight of clean coffee produced. In 1958 a good crop was picked from all plots and, as may be seen in Table XIV, all spray treatments increased the yield of coffee significantly.

TABLE XIV
MACHINE SPRAY TRIAL II
Yield Summary 1957-1958
(Mean annual yield in cwt. clean coffee per acre)

<i>lb. 50% Copper Formulation/100 gall.</i>	<i>Gallons per Acre</i>	<i>Sprayer</i>	<i>1958</i>	<i>1957-1958</i>
Nil	—	—	8.98	7.12
6.8	60	"Agro Airblast"	11.30	8.19
6.8	10	"Micron Meg"	12.44	8.64
13.6	10	" "	13.07	9.91
34.0	10	" "	14.47	10.46
C. of V.% Least Significant Difference			12.03	9.36
p = 0.05			2.23	1.28
p = 0.01			3.14	1.80
p = 0.001			4.43	2.54

A notable feature of the 1958 yields, and thus of the mean annual yields for 1957 and 1958, is the fact that the higher the concentration of copper spray employed the higher the yield of coffee. Hitherto the concentration of 6.8 lb. of a 50% copper formulation in 100 gallons of water has been found to be the optimum strength for spraying to reduce leaf-fall; it is interesting to note that at this strength 10 gallons/acre applied with a "Micron Meg" sprayer has been as effective as 60 gallons per acre applied with an "Agro Airblast" sprayer. No comparison between sprayers is possible at the higher concentrations of copper.

MAKUYU SPRAY TRIAL

This trial was begun in 1954 with the object of determining the best time to spray with copper to reduce premature leaf-fall. Throughout this trial the spray concentration used has been equivalent to mixing 6.8 lb. of a 50% copper formulation in 100 gallons of water. The spray volume applied per tree has been either 1 pint or 1½ pints depending on the average size of the tree in the experimental area.

TABLE XV
MAKUYU SPRAY TRIAL
Yield Summary 1955-1958
 (Mean annual yields in cwt. clean coffee per acre)

<i>Time of Spraying</i>	<i>1958</i>	<i>1955-1958</i>
Nil	10.36	6.64
Early Long Rains (early April)	10.33	8.25
Late Long Rains (late June)	12.11	8.71
Early Short Rains (early November)	9.50	7.76
C. of V. % <i>Least Significant Difference</i>	14.11 <i>Not Significant</i>	7.86
p = 0.05		0.98
p = 0.01		1.41
p = 0.001		2.07

There was no statistically significant effect of treatments in 1958 but it may be seen in Table XV that a number of substantial differences are detectable in the mean yields for the seasons 1955-1958. The best time to spray is evidently at the end of the Long Rains; this treatment has yielded over 2 cwt. of clean coffee a year more than the unsprayed treatment. The early Short Rains treatment has succeeded in raising the yield significantly but to a lesser extent than have either the early or late Long Rains sprays.

KITALE SPRAY TRIAL

TABLE XVI
Summary of Results 1952-1958
 (cwt. clean coffee per acre)
 (Derived by dividing the cherry yield by 6)

<i>Period</i>	<i>Time of Spraying</i>				<i>C. of V. %</i>	<i>Least Significant Difference</i>	
	<i>Nil</i>	<i>May</i>	<i>June</i>	<i>Aug.</i>		<i>p = 0.05</i>	<i>p = 0.01</i>
1958	1.61	1.90	2.65	1.96	37.70	0.63	0.86
1952-1958	6.02	7.57	7.37	6.94			

Only the June spray treatments were effective in increasing the 1958 yields which were unusually poor throughout the trial. Over the seven years this trial has run the spray treatments applied in May have been the most successful. Although none of the interactions between the rate and dilution of copper reaches statistical significance in any year since 1956, there has been a consistent trend for the C₁D₀ treatment to be the most effective of the spray combinations applied in May. On a field scale this corresponds to 1 pint per tree of a fluid containing 6.8 lb. of a 50% copper fungicide to each 100 gallons of water.

VARIETY TRIAL I: COFFEE RESEARCH STATION

Following the 1957 crop the remaining old head of the first cycle of multiple-stem pruning was removed so that the 1958 crop was borne entirely on the three young suckers of the second cycle. There was a light crop on trees of all varieties (overall mean yield of 2.33 cwt. of clean coffee per acre), and there was no important difference between yields.

TABLE XVII

Yield Summary 1953-1958
(Mean annual yields in cwt. clean coffee per acre)

S.L.28	9.80
S.L.19	9.49
S.L.14	9.26
S.L.30	8.79
S.L.1	7.84
S.L.17	7.83
Kit.37	7.64
Kit.107	7.63
Kit.251	7.57
Kit.13	7.54
Kit.85	7.16
Kit.64	7.10
Kit.106	6.79
Kit.109	6.73
Kit.145	6.67
Mean	7.85
Coefficient of Variation%	8.66
<i>Least Significant Difference</i>	
p = 0.05	0.97
p = 0.01	1.30

The yield summary for the first six crops from this trial shows clearly that the selections made originally at the Scott Laboratory (S.L.) have outyielded those from Kitamaiyu Estate (Kit.) amongst which there is little difference.

Of the four highest yielding selections S.L.28 is preferred as it is noted for the good quality of its liquor and its ability to withstand drought more successfully than most other types. S.L.30 is particularly undesirable for, although it has given a fair average yield, it is known to be particularly susceptible to attack by Leaf Rust (*Hemileia vastatrix*) and Coffee Berry Disease (*Colletotrichum coffeanum*).

VARIETY TRIAL II: COFFEE RESEARCH STATION

The yields in 1958 were particularly low because the trees had carried very heavy crops in 1957 and because they were in the process of being converted to a new pruning cycle.

TABLE XVIII
VARIETY TRIAL II
COFFEE RESEARCH STATION, RUIRU
Yield Summary 1954-1958
(Mean annual yields in cwt. clean coffee per acre)

	1958	1954-1958
N.218	2.35	11.18
S.L.34	4.37	10.80
Dalle Mixed	1.90	10.72
K.7	4.86	9.71
S.L.9	3.01	9.19
Series "L"	2.36	8.94
M.83	3.90	8.73
Kenya Selected	3.01	8.63
S.L.28	3.68	8.52
M.6	3.73	8.44
Kents	4.52	8.24
M.65	3.01	8.08
Mocha	3.39	8.07
S.L.3	0.92	8.03
N.100	3.08	7.89
SL.18	3.85	7.74
KP.532	3.21	7.60
S.L.10	1.34	7.54
Dilla and Alghe	3.26	7.25
S.L.6	3.61	7.08
M.48	2.77	6.83
Mean	3.12	8.54
Coefficient of Variation %	17.50	9.12
Least Significant Difference		
p = 0.05	0.76	1.07
p = 0.01	1.00	1.43
p = 0.001	1.31	1.86

Three varieties have yielded at an average rate of over half a ton of clean coffee per acre a year for their first five crops during the period 1954-1958, and it is interesting to see that the rust-resistant selection K.7 has yielded nearly as much coffee as the leading three varieties. S.L.6 is another type showing marked resistance to Leaf Rust but, notwithstanding a series of years during which this disease has been serious, the mean yield from this selection is particularly low.

MAKUYU VARIETY TRIAL

This small trial was planted in 1953 to compare six varieties of coffee under conditions of low altitude (4,800 ft.) and rainfall (36 in. per annum.)

TABLE XIX
MAKUYU VARIETY TRIAL
Yield Summary 1956-1958
(Mean annual yields in cwt. clean coffee per acre)

Variety	1958	1956-1958
S.L.28	10.52	13.86
S.L.14	9.77	11.32
Meru Kents	8.27	11.32
S.L.9	9.58	11.02
Kenya Selected "A"	6.63	10.07
K.7	6.04	10.01
	8.47	11.27
C. of V. %	10.77	12.04
Least Significant Difference		
p = 0.05	1.20	1.79
p = 0.01	1.64	2.44
p = 0.001	2.22	3.30

In each of the three crops harvested for this trial S.L.28 has outyielded the other five varieties, amongst which there is no significant difference in the aggregate yields for 1956-1958. One disturbing feature of this trial has been the falling off in yield of the varieties Kenya Selected Series "A" and K.7.

	1956	1957	1958
Kenya Selected "A"	14.08	9.51	6.63
K.7	14.43	9.55	6.04

An inspection of the trees failed to suggest any reason for this trend, which must be watched closely in the future.

KITALE VARIETY TRIAL

This trial was planted in 1954 to compare various selections (made on the Substation from Blue Mountain and Geisha coffee) with the performance of better-known selections originally made at the Scott Laboratories, e.g., S.L.28 and S.L.34. The coffee is square planted at 9 ft. $\times$ 9 ft.

The experimental design is a 4 $\times$ 4 balanced lattice with one extra replication. There are ten trees per plot, and *Cordia holstii* is used as the shade tree throughout the area of the trial.

TABLE XX
Yield Summary 1957-1958

Variety	Yield of Green Cherry Stripped in September 1957 in Cwt. per Acre	September 1958 % of Trees with Coffee Berry Disease	1958 Clean Coffee in Cwt. per Acre (Cherry yield divided by 6)
1. S.L.28	31.95	75	14.81
2. S.L.2	34.21	57	14.36
3. Geisha I	23.29	30	13.83
4. S.L.1	24.07	70	13.07
5. S.L.34	32.90	62	13.03
6. BM K.7	27.47	32	12.13
7. BM I.5	34.61	28	11.85
8. BM W.12	34.06	48	11.82
9. BM P.8	30.48	47	11.54
10. Kenya Selected	26.95	48	11.45
11. BM Q.6	23.72	68	11.32
12. BM P.12	30.45	33	10.56
13. BM P.13	30.51	28	10.27
14. BM N.1	26.81	30	10.12
15. Kents	24.00	88	9.32
16. Geisha 9	21.26	25	8.33
Coefficient of Variation %	19.80		17.67
Least Significant Difference			
p = 0.05	3.22		1.18
p = 0.01	4.30		1.58

In 1957 the half-formed crop of coffee was stripped, as it appeared that the trees were still not sufficiently mature to carry the crop to ripeness without suffering permanent damage.

A heavy crop was set in 1958, but in September of that season it was observed that the coffee on a number of the trees was severely attacked by Coffee Berry Disease. A scoring of the extent of the damage showed that the crop on Kents was particularly badly infected; on S.L.28, S.L.1 and S.L.34 trees it was considered that the loss of crop would be serious.

The 1958 yields from this trial were high notwithstanding the Coffee Berry Disease, for both S.L.28 and S.L.2 produced more than 14 cwt. of clean coffee per acre and significantly outyielded all the Blue Mountain selections.

KENTMERE VARIETY TRIALS

In 1954 two variety trials were planted on Kentmere Estate, Upper Kiambu, with the object of testing 25 selections for their suitability for high altitudes and for their resistance to Coffee Berry Disease. Trial I is a 4×4 balanced lattice including 14 selections from the Blue Mountain coffee grown on the Coffee Research Substation at Kitale and two other types thought to be suited to conditions at Kentmere. Trial II is a 3×3 balanced lattice including four more Blue Mountain selections and five other varieties. In both trials the coffee was planted at 9 ft. $\times$ 9 ft. with *Grevillea robusta* shade at 54 ft. $\times$ 54 ft. Each recorded plot contains 15 trees in a single row. Normal estate practice has been adopted as the standard of management on these trials, but no sprays against Coffee Berry Disease have been applied.

TABLE XXI

KENTMERE VARIETY TRIALS 1958
(Mean yields in cwt. clean coffee per acre)

<i>Selection</i>	<i>Yield</i>	<i>Selection</i>	<i>Yield</i>
1. Blue Mountain P.13	6.11	S.L.34	9.54
2. Blue Mountain K.7	5.90	S.L.28	9.54
3. Blue Mountain R.12	5.54	Kents	9.27
4. Blue Mountain I.11	5.36	Blue Mountain I.5	8.39
5. Blue Mountain L.3	4.83	Blue Mountain N.4	8.29
6. Blue Mountain P.8	4.75	Blue Mountain U.4	8.14
7. Blue Mountain Q.6	4.75	Ke 20	8.10
8. Blue Mountain P.12	4.70	Geisha 1	7.93
9. Blue Mountain N.1	4.41	Blue Mountain X.6	7.20
10. Blue Mountain S.10	4.28		
11. Blue Mountain J.7	4.17		
12. Blue Mountain S.5	3.96		
13. Kenya Selected	3.95		
14. Blue Mountain W.12	3.68		
15. Blue Mountain V.13	3.62		
16. Geisha 10	3.58		
Mean	4.60		8.49
Coefficient of Variation	18.93		11.46
<i>Least Significant Difference</i>			
p = 0.05	1.11		1.46
p = 0.01	1.48		2.10

The marked difference between the mean yields from Trials I and II reflects the early history of these two experiments: from the time of planting the seedlings in Trial II grew well while many of those in Trial I had to be replanted. No great weight should be attached to these results, which are only based on the first crop from these trees, but it is noticeable that in 1958 no selection yielded more than S.L.28 or S.L.34.

CENTRAL PROVINCE: MERU DISTRICT

MERIGA MIERU VARIETY TRIAL (MERU SEED FARM)

Altitude: 5,500 ft.

Rainfall: 53 inches.

Date Planted: 1951.

Spacing: 9 ft. $\times$ 9 ft.

Layout: A 5×5 Latin square with nine-tree plots.

Results

TABLE XXII
MERIGA MIERU VARIETY TRIAL 1954-1958
(Mean annual yields in cwt. clean coffee per acre)
(Derived by dividing cherry yield by 6)

Variety	1958	1954-1958
S.L. 28	16.81	16.46
S.L. 34	17.06	16.39
Kenya Selected	9.89	13.93
N. 100	8.86	11.46
Meru Kents	7.61	9.90
C. of V. %	30.89	
Least Significant Difference		
p = 0.05	5.12	
p = 0.01	7.21	
p = 0.001	9.96	

During 1958/59 the varieties S.L.34 and S.L.28 again produced a heavy crop. By comparison the yield of the other varieties was only moderate. The varieties S.L.34 and S.L.28 outyielded significantly Kenya Selected ($p = 0.05$); N.100 and Meru Kents ($p = 0.01$). Results obtained between 1954-1958 clearly show the superiority of S.L.34 and S.L.28 over Meru Kents.

CENTRAL PROVINCE: MERU DISTRICT KIRIANI VARIETY TRIAL (CHOGORIA)

Altitude: 5,100 ft.
Date Planted: 1951.
Spacing: 9 ft. $\times$ 9 ft.

Rainfall: 62 inches.

Layout: A 5 $\times$ 5 Latin square with nine-tree plots.

Results

TABLE XXIII
KIRIANI VARIETY TRIAL 1954-1958
(Mean annual yields in cwt. clean coffee per acre)
(Derived by dividing cherry yields by 6)

Variety	1958	1954-1958
S.L. 18	13.25	14.26
S.L. 9	14.79	13.87
S.L. 28	12.05	12.65
Meru Kents	8.05	12.19
Mocha	5.46	8.29
C. of V. %	34.91	
Least Significant Difference		
p = 0.05	5.15	
p = 0.01	7.25	

The varieties S.L.18 and S.L.9 continued to provide the highest yields during 1958/59. S.L.28 also produced another good crop. The variety Meru Kents gave a fair yield and Mocha was disappointing with a yield of only 5.46 cwt. S.L.18 and S.L.9 significantly outyielded Mocha ($p = 0.01$) and Meru Kents ($p = 0.05$).

CENTRAL PROVINCE: MERU DISTRICT KIGUCHWA VARIETY TRIAL (TIGANIA)

Altitude: 4,700 ft.

Rainfall: 46 inches.

Date Planted: 1951.

Spacing: 9 ft. $\times$ 9 ft.

Layout: A 5 $\times$ 5 Latin square with single-tree plots.

Results

TABLE XXIV
KIGUCHWA VARIETY TRIAL 1955-1958
(Mean annual yields in cwt. clean coffee per acre)
(Derived by dividing cherry yield by 6)

<i>Variety</i>	<i>1958</i>	<i>1957</i>	<i>1955-1958</i>
Meru Kents	1.01	14.86	6.24
S.L. 9	0.89	25.57	11.31
S.L. 34	0.34	17.01	7.11
N. 100	0.32	16.78	8.45
S.L. 28	0.00	31.80	12.01
C. of V. %	160.87		
<i>Least Significant Difference</i> $p = 0.05$	1.13		

As was anticipated, the extremely heavy crops produced in 1957 have resulted in very low yields in 1958. It is very doubtful whether the trees in this trial will ever recover because the overbearing has caused serious dieback. It is possible that the trees will not be able to produce new suckers.

CENTRAL PROVINCE: MERU DISTRICT KAJIANDUTHI VARIETY TRIAL (MUTHAMBI)

Altitude: 4,600 ft.

Rainfall: 56 inches.

Date Planted: 1951.

Spacing: 9 ft. $\times$ 9 ft.

Layout: A 5 $\times$ 5 Latin Square with single-tree plots.

Results

TABLE XXV

KAYIANDUTHI VARIETY TRIAL 1954-1958
(Mean annual yields in cwt. clean coffee per acre)
(Derived by dividing cherry yield by 6)

<i>Variety</i>	<i>1958</i>	<i>1954-1958</i>
Meru Kents	16.63	16.88
S.L. 28	7.23	14.78
S.L. 18	14.21	12.31
Series L ^a	5.12	12.19
Mocha	9.23	10.31
C. of V. %	59.93	
<i>Least Significant Difference</i>		
p = 0.05	8.66	
p = 0.01	12.16	

In 1958 Meru Kents significantly outyielded S.L.28 ($p = 0.05$) and Series L ($p = 0.01$). The variety S.L.28 has yet to recover completely from the heavy crops produced in 1955 and 1957.

CENTRAL PROVINCE: MERU DISTRICT NGERU VARIETY TRIAL (LOWER MWIMBE)

Altitude: 4,000 ft.
Date Planted: 1954.
Spacing: 9 ft. $\times$ 9 ft.

Rainfall: 65 inches.

Layout: A 7×7 Latin square with single-tree plots.

Results

TABLE XXVI

NGERU—LOWER MWIMBE VARIETY TRIAL 1957-1958
(Mean annual yields in cwt. clean coffee per acre)
(Derived by dividing cherry yields by 6)

<i>Variety</i>	<i>1958</i>	<i>1957-1958</i>
S.L. 14	12.93	13.33
Kenya Selected	12.36	10.64
Series L	10.61	10.62
K. 7	15.16	9.41
S.L. 28	5.60	5.52
Columnaris	6.97	3.59
Barbuk Forest	5.45	3.02
C. of V. %	64.53	
<i>Least Significant Difference</i>		
p = 0.05	5.21	
p = 0.01	6.68	
p = 0.001	8.86	

This trial is situated in the Leaf Rust (*Hemileia vastatrix*) disease endemic zone of Meru District. The Leaf Rust resistant variety K.7 is outstanding, having produced a heavy crop in 1958. K.7 significantly outyielded Barbuk Forest and S.L.28 ($p = 0.001$); also Columnaris ($p = 0.01$).

CENTRAL PROVINCE: MERU DISTRICT

IGEMBE VARIETY TRIAL

Altitude: 4,200 ft.
Date Planted: 1951.
Spacing: 9 ft. = 9 ft.

Rainfall: 90 inches.

Layout: A 5 × 5 Latin square with single-tree plots.

Results

TABLE XXVII
 IGEMBE VARIETY TRIAL 1955-1958
 (Mean annual yields in cwt. clean coffee per acre)
 (Derived by dividing cherry yields by 6)

<i>Variety</i>	<i>1958</i>	<i>1955-1958</i>
S.L. 28	15.31	15.88
N. 39	11.37	10.84
Meru Kents	10.31	10.48
Blue Mountain	7.80	9.02
Dalle	7.43	9.02
C. of V. %	55.42	
<i>Least Significant Difference</i> $p = 0.05$	7.94	

S.L.28 outyielded all other varieties in the trial but differences in crop were insufficient to achieve statistical significance. The crop produced by the varieties Blue Mountain and Dalle was disappointing.

CENTRAL PROVINCE: MERU DISTRICT

KANUNI (LOWER IGEMBE) VARIETY TRIAL

Altitude: 4,100 ft.
Date Planted: 1954.
Spacing: 9 ft. × 9 ft.

Rainfall: 75 inches.

Layout: A 7 × 7 Latin square with single-tree plots.

Results

TABLE XXVIII
KANUNI (LOWER IGEMBE) VARIETY TRIAL 1958
(Yields in cwt. clean coffee per acre)
(Derived by dividing cherry yield by 6)

Variety	1958
S. L. 28	19.90
Series L	17.74
S.L. 14	15.03
K. 7	12.91
Kenya Selected	10.48
Columnaris	7.96
Barbuk Forest	5.52
C. of V. %	42.11
Least Significant Difference	
p = 0.05	5.89
p = 0.01	7.93
p = 0.001	10.51

The heavy crop produced by S.L.28 was outstanding; Series L and S.L.14 also yielded good crops. S.L.28 significantly outyielded K.7 ($p = 0.05$), Kenya Selected ($p = 0.01$), Columnaris and Barbuk Forest ($p = 0.001$); Series L also gave a sufficiently heavy crop to outyield Kenya Selected ($p = 0.05$), Columnaris ($p = 0.01$), and Barbuk Forest ($p = 0.001$). It will be interesting to see whether such heavy crops can be borne without causing permanent damage to the trees.

CENTRAL PROVINCE: EMBU DISTRICT EMBU INVESTIGATION CENTRE VARIETY TRIAL

Altitude: 4,800 ft.

Rainfall: 41 inches.

Date Planted: 1950.

Spacing: 9 ft. $\times$ 9 ft.

Layout: A 5 $\times$ 5 Latin square with nine-tree plots.

Results

TABLE XXIX
EMBU INVESTIGATION CENTRE VARIETY TRIAL 1953-1958
(Mean annual yield in cwt. clean coffee per acre)
(Derived by dividing the cherry yield by 6)

Variety	1958	1953-1958
S.L. 14	12.88	12.80
S.L. 34	13.62	12.71
S.L. 28	13.59	12.25
N. 197	11.04	10.91
Kents	9.63	10.32
C. of V. %	15.06	
Least Significant Difference		
p = 0.05	2.51	
p = 0.01	3.54	
p = 0.001	4.88	

The three S.L. selections continue to produce more crop than N.197 and Kents. S.L.34 and S.L.28 significantly outyielded Kents ($p = 0.01$) and N.197 ($p = 0.05$). S.L.14 continues to occupy the leading position in the mean annual yields for the six crops so far recorded.

NYANZA PROVINCE: SOUTH NYANZA KISII FARM VARIETY TRIAL

Altitude: 5,600 ft. *Rainfall:* 67 inches.
Date Planted: 1950.
Spacing: 9 ft. $\times$ 9 ft.

Layout: A 7 $\times$ 7 Latin square with nine-tree plots.

Results

TABLE XXX
KISII FARM VARIETY TRIAL 1953-1958
 (Mean annual yields in cwt. clean coffee per acre)
 (Derived by dividing the cherry yields by 6)

<i>Variety</i>	<i>1958</i>	<i>1953-1958</i>
S.L. 28	5.81	6.56
S.L. 14	5.64	6.26
Kenya Selected	4.85	5.41
Thorolds	4.06	5.31
Kit. 145	8.53	5.25
Kents	3.88	4.89
Blue Mountain	4.63	4.75
C. of V. %	29.73	
<i>Least Significant Difference</i>		
$p = 0.05$	0.78	
$p = 0.01$	1.06	
$p = 0.001$	1.40	

The amount of crop produced by varieties in this trial was only fair. Kit.145 produced by far the heaviest crop in 1958 to significantly outyield all other varieties in the trial ($p = 0.001$).

Although S.L.28 has the best mean annual yield of 6.56 cwt. this would be considered a poor yield in coffee areas East of the Rift Valley.

NYANZA PROVINCE: SOUTH NYANZA MOSOCHO VARIETY TRIAL

Altitude: 5,200 ft. *Rainfall:* 65 inches.
Date Planted: 1951.
Spacing: 9 ft. $\times$ 9 ft.

Layout: A 9 $\times$ 9 Latin square with single-tree plots.

Results

TABLE XXXI
MOSOCHO VARIETY TRIAL 1958
(Yields in cwt. clean coffee per acre)
(Derived by dividing cherry yields by 6)

Variety	1958
Thorolds	13.80
Kents	12.47
S.L. 14	9.85
Kenya Selected	8.26
S.L. 28	7.38
N. 100	6.99
Mocha	6.34
S.L. 34	5.46
S.L. 3	1.71
C. of V. %	51.60
Least Significant Difference	
p = 0.05	3.99
p = 0.01	5.31
p = 0.001	6.76

The results for 1958 show a great variation in the level of crop produced by different varieties. Kents and Thorolds have shown some resistance to Leaf Rust at Mosocho but Mocha and S.L.3 are very susceptible to the disease. Thorolds and Kents significantly outyielded S.L.3 and S.L.34 ($p = 0.001$). Kenya Selected, S.L.28, N.100 and Mocha were also outyielded at lower levels of significance ($p = 0.01$ and $p = 0.05$) by Thorolds and Kents.

NYANZA PROVINCE: SOUTH NYANZA KEUMBU VARIETY TRIAL

Altitude: 6,200 ft.

Rainfall: 80 inches.

Date Planted: 1951.

Spacing: 9 ft. $\times$ 9 ft.

Layout: 9 $\times$ 9 Latin square with single-tree plots.

Results

TABLE XXXII
KEUMBU VARIETY TRIAL
(Mean yields in cwt. clean coffee per acre)
(Derived by dividing cherry yield by 6)

Variety	1958
Thorolds	11.44
S.L. 2	10.45
S.L. 14	9.68
S.L. 28	9.36
Mocha	9.16
S.L. 34	9.05
N. 100	8.91
Kenya Selected	8.86
Kents	8.08
C. of V. %	37.66
Least Significant Difference	
p = 0.05	3.60

It is only recently that the first results from this trial have become available for analysis. The differences in crop were not sufficiently great to attain statistical significance. It is interesting to note that the crops produced at Keumbu (altitude 6,200 ft.) are much greater than those produced at the Kisii Farm (altitude 5,600 ft.)

NYANZA PROVINCE: SHIKUSU VARIETY AND PRUNING TRIAL

Altitude: 5,000 ft.

Rainfall: 70 inches.

Date Planted: 1954.

Spacing: 9 ft. $\times$ 9 ft.

Object: To compare seven coffee varieties under conditions at Shikusu when pruned according to three systems of secondary growth control.

Layout: Main Treatments: Seven varieties arranged in a 7×7 Latin square with nine trees per plot.

Sub-treatments: Three methods of controlling secondary growth. Each main plot being divided into three sub-plots of three trees each.

R: Secondary growth removed at all times.

J: Secondary growth removed for the first crop on each primary and then allowed to remain for the second crop in the following year.

C: Secondary growth removed at all times from the proximal 12 inches of each primary.

Results

TABLE XXXIII
SHIKUSU VARIETY $\times$ PRUNING TRIAL 1957-1958
(Mean annual yields in cwt. clean coffee per acre)
(Derived by dividing the cherry yield by 6)

<i>Variety</i>	<i>1958</i>	<i>1957-1958</i>	<i>Pruning treatments</i>	<i>1958</i>	<i>1957-1958</i>
S.L. 34	5.42	4.31	R. All secondary growth removed. J. Secondaries removed for first crop of each primary C. Secondaries removed from proximal 12" of each primary	3.08	2.84
Kents	4.31	3.61			
S.L. 28	4.12	3.62		2.80	2.79
S.L. 14	3.96	3.68			
S.L. 2	3.81	3.79		5.40	4.19
Kapretwa Series A	3.67	3.39			
K.7	0.75	—			
C. of V. %	44.46			51.50	
<i>Least Significant Difference</i>					
p = 0.05	0.60			0.70	
p = 0.01	0.82			1.03	
p = 0.001	1.08			1.32	

The variety S.L.34 was outstanding during 1958, significantly outyielding all the other varieties in the trial ($p = 0.001$). The variety K.7 was planted in 1956 to replace the variety S.L.30.

In the pruning trial Treatment C involving the least reduction in secondary growth outyielded Treatments R and J ($p = 0.001$). This confirms the trend shown in the 1957 results.

COAST PROVINCE: WUNDANYI VARIETY TRIAL

TEITA DISTRICT

Altitude: 5,400 ft.

Rainfall: 53 inches.

Date Planted: 1950.

Spacing: 9 ft. $\times$ 9 ft.

Layout: A 6 $\times$ 6 Latin square with six trees per plot.

Results

TABLE XXXIV

WUNDANYI VARIETY TRIAL 1954-1958
(Mean annual yields in cwt. clean coffee per acre)

<i>Variety</i>	<i>1958</i>	<i>1954-1958</i>
S.L. 34	3.97	9.08
K. 7	2.97	9.07
S.L. 28	4.98	9.04
Kents	3.14	8.97
KP. 532	3.61	8.86
S.L. 14	3.65	8.13
C. of V. %	31.05	
<i>Least Significant Difference</i>		
p = 0.05	1.40	
p = 0.01	1.91	
p = 0.001	2.58	

The crop during 1958 was small because the trial was commencing a new cycle. S.L.28 significantly outyielded K.7 ($p = 0.01$) and Kents ($p = 0.05$). The five-year mean yields show that there has been only a very small difference between yields throughout the course of the trial.

MULCH GRASS INVESTIGATIONS

Yields

During the past two years 14 quarter-acre plots have been established with various species and strains of grass which were thought might produce material with which to mulch the coffee.

The grasses were planted on a rather shallow slope of Kikuyu Red Loam on which there was formerly a poor coffee plantation.

The growth made by the grasses during each Rains period is allowed to mature before being cut and weighed. At the time of harvest samples of grass have been taken for the determination of moisture and potassium content. The data available so far are summarized in Table XXXV.

TABLE XXXV
YIELDS OF GRASSES FOR MULCHING COFFEE: TONS OF DRY MATTER
PER ACRE

Grass	Total Yield from 2 cuts per year (July and February)		Weight required to apply a layer of mulch between all rows of an acre of coffee planted at 9' × 9'
	1957 L.R. + 1957 S.R.	1958 L.R. + 1958 S.R.	
<i>Pennisetum purpureum</i> (Local Hairy)	16.61	14.84	19.34
(ex Cameroons)	17.15	13.25	20.66
(Hairless Clone S-4)	11.84	11.46	18.05
<i>Hyparrhenia rufa</i>	5.26	2.10	14.81
" <i>ruprechtii</i>	2.54	1.32	15.44
" <i>cymbaria</i>	—	4.96	—
" sp. (ex 11-4 Scott Laboratory)	10.29	9.55	22.51
" sp. (ex 11-5 Scott Laboratory)	—	4.62	—
<i>Cymbopogon validus</i>	5.71	4.85	18.39
" <i>afronardus</i>	6.47	7.41	20.00
<i>Panicum maximum</i>	6.85	11.73	24.04
	(1 cut only)		
" <i>coloratum sensulatum</i>	—	13.72	—
<i>Cynodon</i> sp. (Giant Star Grass)	—	7.87	—
<i>Sorghum sudanense</i>	2.40	1.27	22.33

In general it is clear that the various forms of *Pennisetum purpureum* have produced the highest yields of dry matter per acre, but certain other grasses have shown considerable promise.

In order to estimate the acreage of grass necessary to mulch an acre of coffee the product of each grass plot was laid in an adjacent coffee plantation and the extent of its cover recorded. In this way the figures in the extreme right-hand column were obtained. From this it may be calculated that in 1958/59 about 1.3 acres of the local hairy Napier grass would have produced sufficient material to mulch between all rows of an acre of coffee planted at 9 ft. × 9 ft. The corresponding figures for *Hyparrhenia* sp. 11-4 and *Panicum maximum* (Mackinnon Road) would have been 2.3 acres and 2.0 acres respectively.

Persistence

TABLE XXXVI
MULCH PERSISTENCE

Grass	Initial Depth in August, 1957	Depth of Mulch February, 1958
<i>Pennisetum purpureum</i> (Local Hairy)	6 inches	3 inches
(ex Cameroons)	6 "	1 "
(Hairless Clone S-4)	6 "	2½ "
<i>Hyparrhenia rufa</i>	6 "	3 "
<i>Cymbopogon validus</i>	6 "	4 "
" <i>afronardus</i>	6 "	4 "

In August, 1957, measured depths of mulch were laid down using six different types of grass. These strips of mulch were examined six months later after the Short Rains of 1957 were over and the observations summarized in Table XXXVI. The *Pennisetum purpureum* from the Cameroons decomposed particularly rapidly so that the mulch layer decreased in thickness by five inches in six months. The local hairy form of *P. purpureum* was distinctly superior to the imported and hairless forms, but was definitely inferior to the *Cymbopogon* spp. which gave a mulch of good persistence.

The reduction in depth from six to four inches was not important because a four-inch layer of mulch is considered quite adequate in coffee.

In view of the development of forage harvesters, which lacerate the material they cut, a small observation trial was laid down to study the effect on mulch persistence of cutting up *Pennisetum purpureum* to varying extents.

TABLE XXXVII
THE EFFECT OF CUTTING UP PENNISETUM PURPUREUM ON ITS PERSISTENCE

Length of Grass	August, 1957		February, 1958	
	Depth in inches	Weight in kg.	Depth in inches	Weight in kg.
A 10 ft.	6	200	2	32
B 5 ft.	6	200	1½	22
C 2 ft.	6	200	1½	21
D 1 ft.	6	200	1½	22
E Shredded	6	200	½	14

In August, 1957, 1,000 kg. of freshly cut *P. purpureum* was divided into five equal lots which were treated as shown in Table XXIV. In treatment A the grass was not cut at all and in treatments B, C and D the grass was cut up by hand. For treatment E the grass was passed through a small rotary lawnmower which reduced the 200 kg. of grass to a small heap of shredded material. The grass was then laid in strips six inches thick and not touched for six months. In February the effective depth of the mulch was measured again and all the material which could be recovered weighed once more. The results of this trial are summarized in Table XXXVII, which shows that in reducing the length of grass from 10 to 5 ft. its persistence was slightly reduced, but between the 5, 2 and 1-ft. lengths of grass there was no appreciable difference. The shredded grass decomposed rapidly and did not provide an effective mulch six months after it had been applied in a layer six inches deep. From these results it appears that *P. purpureum* grown for mulch may be reduced to 1-ft. lengths without reducing its persistence unduly, although the full lengths of grass are more persistent. However, it was observed that none of the 1-ft. lengths of grass rooted in the coffee while several of the full-length pieces rooted vigorously.

The Potassium Content of Grasses Used for Mulch

The potassium content of the various grasses is considered important because it has been found that when *Pennisetum purpureum* is used as the mulch material such great quantities of the element are applied to the coffee that the uptake of magnesium is reduced and deficiency symptoms ensue.

TABLE XXXVIII
MULCH GRASSES AND THEIR POTASSIUM CONTENT

Grass	Long Rains 1958		Short Rains 1958		Lb. of K applied when applying mulch between all rows of a coffee plantation spaced at 9' x 9'	
	Tons DM/acre	% K	Tons DM/acre	% K		
					Long Rains	Short Rains
<i>Pennisetum purpureum</i> (Local)	9.86	5.98	4.98	2.75	2,591	1,191
<i>P. purpureum</i> (ex Cameroons)	9.37	3.04	3.88	2.37	1,407	1,097
<i>Cymbopogon afronardus</i>	6.00	1.14	1.41	1.32	511	591
<i>Panicum maximum</i> (ex Mackinnon Road)	9.78	2.25	1.95	2.24	1,212	1,206
<i>Hyparrhenia</i> sp. (ex plot—4 S.A.L.)	6.31	1.52	3.24	0.85	767	429
<i>Hyparrhenia rufa</i>	1.44	0.91	0.66	1.10	302	365

From the grass harvest following each of the 1958 Rains samples were taken for chemical analysis. Some of these figures are presented in Table XXXVIII, from which it may be seen the content of potassium varied greatly with the grass species; in the case of *Pennisetum purpureum* the content after the Short Rains was appreciably lower than that determined from the samples taken after the Long Rains, when over a ton of potassium would have been applied per acre of coffee mulched between all rows.

Hyparrhenia sp. (11-4) and *Cymbopogon afronardus* combined moderate yields with fairly low contents of potassium but, although the chemical analysis of *Hyparrhenia rufa* was satisfactory, the yields were very low indeed.

VEGETATIVE PROPAGATION STUDIES

Cuttings

Electrical soil-warming equipment with thermostatic control was installed in three frames with the object of reducing the time required to produce rooted coffee cuttings. The first results show that the time taken for rooting was only reduced by about two weeks and that internodal cuttings produced roots more quickly than nodal cuttings in a constant temperature of 72°F.

Composts for Coffee Cuttings

Two types of vermiculite were tested in various combinations with coffee hulls, coarse sand and Kikuyu Red Loam. The results obtained showed that a mixture of $\frac{1}{4}$ vermiculite, $\frac{1}{4}$ coffee hulls and $\frac{1}{2}$ coarse sand gave the best results.

Mist Propagation

A type of Mist Propagator approved by the National Institute of Agricultural Engineering was installed at the end of 1958. The mist propagation technique has been very successful in temperate countries for the rooting of evergreen and deciduous trees and shrubs. It is hoped that the intermittent mist produced will also be suitable for the rooting of coffee cuttings.

AGRICULTURAL CHEMISTRY

SOIL NITROGEN AND RELATED STUDIES

Little new work has been undertaken this year with the study of soil nitrogen changes in relation to nitrogen fertilizers and mulches. A detailed appreciation of results obtained to date followed by a comprehensive series of reports now remains to be completed.

At an early stage in the study of the field trends and fluctuations of natural nitrate nitrogen ($\text{NO}_3\text{-N}$) steady accumulation or build-up in the topsoil was observed during the dry weather following a rains period. Although an obvious explanation was that of formation "in situ", it was pointed out by Dr. E. W. Russell, Director of the East African Agriculture and Forestry Research Organization, that with the strong drying out of the topsoil there might also be an upward movement of $\text{NO}_3\text{-N}$ from lower down in the soil profile. It was important to be able to differentiate between $\text{NO}_3\text{-N}$ formed in the immediate topsoil and $\text{NO}_3\text{-N}$ which may have accumulated there following upward movement.

As a result of laboratory investigations with soil columns in which a significant positive correlation was found between the vertical distribution of the chloride (Cl) ion and the nitrate ion under different water régimes and with differential heating of the surface of the soil columns, a trial was laid down late in 1957 to investigate this relationship under field conditions.

An experiment to examine the relationship between the distribution of chloride and nitrate ions in the soil profile

In November, 1957, a uniform area of fallow coffee soil was divided into six plots of 169 square feet each. In late November ammonium chloride was applied to three of the plots, one in each block of two plots, at a rate of 5 cwt. per acre; the second plot in each of the three blocks was left as an untreated control. The time of application was chosen to coincide with the latter part of the Short Rains so that the fertilizer would be distributed through the upper part of the profile and to permit nitrification of the added ammonium ion. The Short Rains are followed by a hot, sunny drought period, i.e., January to mid-March, before the Long Rains arrive.

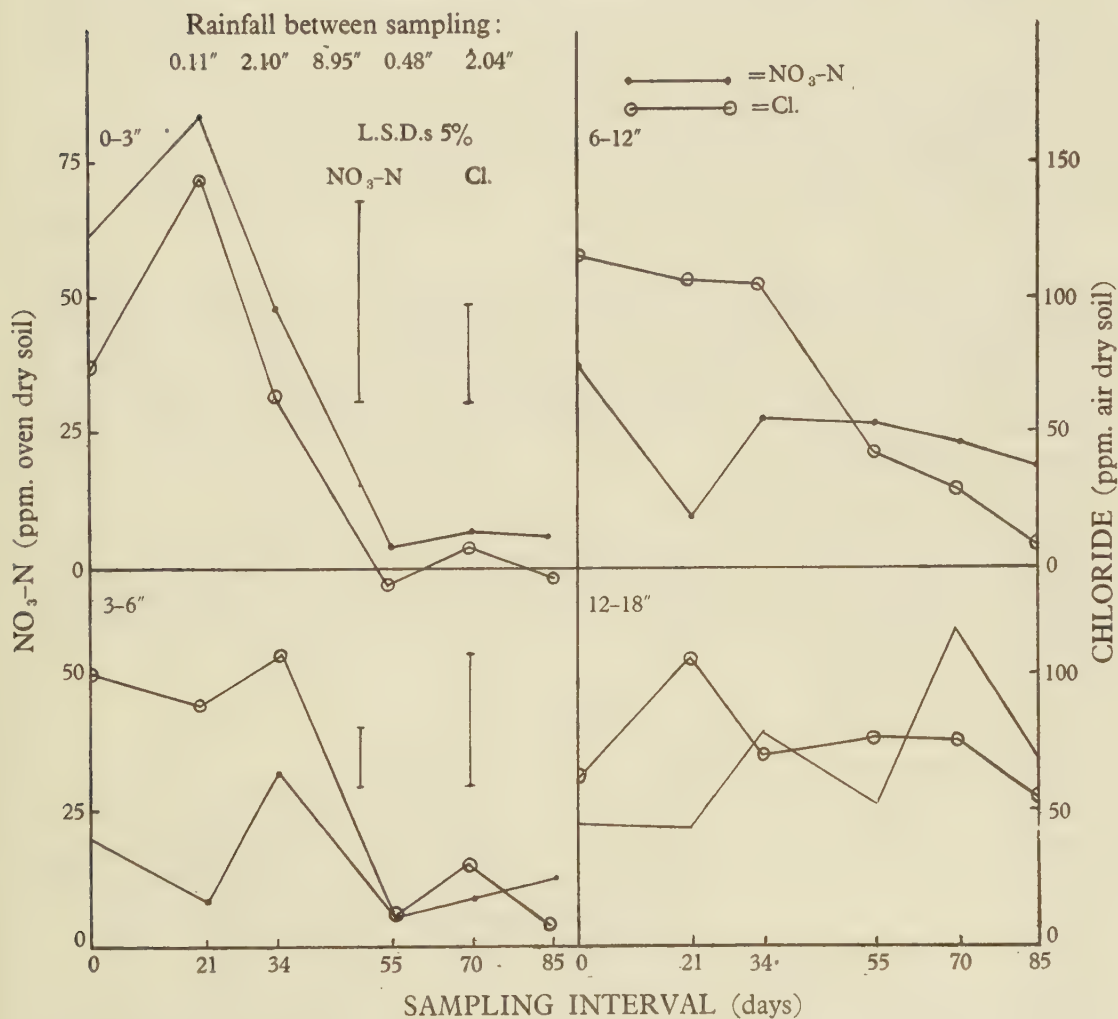
Between November, 1957, and March, 1958, six sets of soil samples were collected from each of these plots at specific vertical intervals to a depth of 18". The fresh samples were analysed immediately for $\text{NO}_3\text{-N}$ by the phenoldisulphonic acid method, and the air dry samples were analysed for Cl by the mercurimetric method of Lapin and Zamanov (1). It was assumed that the vertical movements of both $\text{NO}_3\text{-N}$ and Cl were in parallel for the ammonium chloride treated and untreated plots and that by subtracting the values found for the untreated soil from the ammonium chloride treated soil the presence of natural $\text{NO}_3\text{-N}$ and Cl would be eliminated. A summary of the movements of added nitrogen in the form of NO_3 , and of Cl, is given in Figure I.

A highly significant positive correlation between $\text{NO}_3\text{-N}$ and Cl for different sampling times was found in the 0-3" and 3-6" soil samples, +0.70*** and +0.72*** respectively. No such relationship was found in the 6-12" and 12-18" soil samples. Where the rainfall was very slight between the first and the second samplings, a non-significant, although appreciable, rise in both $\text{NO}_3\text{-N}$ and Cl was found in the 0-3" sample together with a reflected decrease of these ions in the 3-6" sample. Between the second and the third sampling times, leaching of both $\text{NO}_3\text{-N}$ and Cl occurred from the 0-3" depth as the result of heavy unseasonal rainfall, and partial accumulation at the 3-6" and possibly the 6-12" sample depths. Further heavy rainfall between the third and the fourth sampling times resulted in additional leaching throughout the profile, although it was more intense from the top six inches.

The results of this simple experiment suggest that (i) it is possible under field conditions to follow the movement of added $\text{NO}_3\text{-N}$ in the upper 6" of the soil profile at least, by tracing the movement of added Cl; (ii) in dry weather $\text{NO}_3\text{-N}$ and Cl appear to move upwards in the soil profile from the 3-6" to the 0-3" depth; and (iii) appreciable leaching of both $\text{NO}_3\text{-N}$ and Cl takes place when rainfall is heavy.

More experimental work is required with this technique; it is possible that sampling at closer vertical intervals will result in figures that are more closely related and which will provide for a more critical evaluation of $\text{NO}_3\text{-N}$ movements in the soil. It is a technique which might also be of value in the study of $\text{NO}_3\text{-N}$ distribution within the ten-foot soil profile and it will be tested as a method for studying "in situ" the movement of added fertilizer nitrogen below the dense surface root mat of coffee.

FIGURE I. THE RELATIONSHIP BETWEEN NITRATE AND CHLORIDE IN THE SOIL



The influence of nitrogen fertilizers on growth, leaf nitrogen content and yield (Experiment No. II)

The treatments were continued in this trial during 1958 (2) and the yield results are summarized in Table XXXIX.

TABLE XXXIX
Mean Yield Results
(Cwt. clean coffee per acre per annum)

		(1)	S/A	Split S/A	Urea	Split Urea	Mean
(1)	a	5.9 (12)	7.5	7.4	6.7	5.8	6.7
	b	1.7 (4)	2.4	3.3	1.7	1.6	2.1
Mulch	a	5.6	6.8	8.5	5.2	8.0	6.8
	b	4.0	2.4	1.8	4.1	3.7	3.2
Mean	a	5.8 (48)	7.2	7.9	5.9	6.9	
	b	2.8 (8)	2.4	2.6	2.9	2.7	
Grouped	a	5.8	7.6		6.4		
Mean	b	2.8	2.5		2.8		

- (a)=Mean annual yields of 4 replications over 3 seasons (12), 1956-1959.
(b)=Mean yields of 4 replications for the 1958/59 season (4); the first crop from a new cycle of multiple-stem heads.
S/A=Ammonium sulphate.
- The figures in brackets in this and subsequent tables are the number of values contributing to the mean value.

As none of these mean values reached statistical significance it is not possible to draw any conclusions, but it is interesting to note that, over three crop seasons (a), split applications of nitrogen fertilizer applied on top of a mulch appear to have given satisfactory yield responses. The yield difference between the two types of nitrogen fertilizers (grouped means) is smaller than it was for the two years' results previously reported because the first crop yields from the multiple-stem cycle (b) do not show this difference at all. Mulch would appear to have increased the yield obtained from the first year of the new cycle.

In previous years numerous leaf samples have been collected from this trial and analysed for total nitrogen content. Differences between treatments measured in this way have been small, perhaps because of "dilution effect" attributable to increased growth in the presence of nitrogen fertilizer. Leaf samples were not collected in 1958 but, during the middle of the harvest period, cherry samples were collected and analysed to determine whether they would provide a more critical index of nitrogen uptake from the treatments.

TABLE XL
Nitrogen Content of Ripe Cherry

		(1)	S/A	Split S/A	Urea	Split Urea	Mean
(1)	a	1.082 (4)	1.171	1.113	1.098	1.089	1.110 (20)
	b	2.4 (4)	3.8	4.9	2.9	2.6	3.3 (20)
Mulch	a	1.050	1.164	1.191	1.112	1.170	1.137
	b	5.6	3.8	2.9	6.2	5.8	4.9
Mean	a	1.066 (8)	1.167	1.152	1.104	1.129	
	b	4.0 (8)	3.8	3.9	4.5	4.2	
Grouped	a	1.066	1.159		1.116		
Means	b	4.0	3.9		4.3		

- (a)=Nitrogen per cent in leaf dry matter (Means of 4 replications).
(b)=Calculated nitrogen in lb. per acre removed in the crop (approximate only).

The mean results for nitrogen per cent in the dry matter of mature cherry have failed to reach a reasonable level of statistical significance although there is some indication that the nitrogen content is higher in samples from the fertilizer treated plots. The calculated figures for total nitrogen removed per acre in the crop show the increased loss of nitrogen from the mulched coffee except where ammonium sulphate fertilizer has been applied. These results largely parallel the differences in yield recorded in Table XXXIX.

Laboratory incubation studies on the Kikuyu red loam coffee soil

A second experiment was carried out of the same type, and in the same manner, as the experiment previously reported (3) to determine the effect of plant nutrient additions to the soil on the mineralization of natural soil nitrogen. A further bulk sample of topsoil was collected from an unmulched coffee area and the figures obtained confirm the results of the previous test. The withholding of all or of any one micronutrient, and of either calcium or phosphorus, resulted in no significant effect on the ammonification or nitrification of natural nitrogen.

An incubation method for determining plant available nitrogen proposed by Lenhard (4) was examined preliminarily in one experiment and the results obtained are of some interest. The method is stated to determine the amounts of nitrogen mineralized within a given time from the humic matter of the soil under constant and reproducible conditions. Mineral nitrogen in the soil subject to seasonal changes and nitrification of ammonium salts added to the soil are stated to be eliminated before the test by extraction with a calcium sulphate reagent.

In view of the known effect of pre-drying a Kikuyu red loam coffee soil on the mineralizable nitrogen levels (5) a bulk topsoil sample was collected during dry weather in January and, after subsampling, a comparison was made between the fresh and the pre-dried samples $\pm$ extraction with the calcium sulphate reagent before incubation. (Pre-drying consisted of overnight in an air oven at 50°C.) Replicated samples were withdrawn for analysis after 14 days, as in the published method and at 28 days. Results were analysed statistically after the values for $\text{NO}_3\text{-N}$ content of both the fresh and the pre-dried subsamples at 0 days had been subtracted from the values found after 14 and 28 days of incubation at 30°C. and a moisture level of 50% field capacity.

TABLE XLI
Nitrate Nitrogen Levels
(ppm. $\text{NO}_3\text{-N}$ in oven dry soil)

<i>Incubation Time</i>		<i>Fresh Soil</i>		<i>Pre-dried Soil</i>		<i>L.S.D.s</i>
		A	B	A	B	
14 days		14.3 (2)	6.8	16.8	9.5	33.9*
28 days		20.3	13.5	182.8	26.2	48.2**
Overall Means (4)		17.5 (4)	10.2	99.8	17.9	24.1*
						34.2**

Initial $\text{NO}_3\text{-N}$ level in both fresh and pre-dried soil = 16.2 ppm.

Moisture content during incubation = 32.7%.

A = No extraction with calcium sulphate before incubation.

B = Extracted with calcium sulphate before incubation.

Extracting the pre-dried soil with calcium sulphate before incubation has apparently removed almost entirely the source of the additional $\text{NO}_3\text{-N}$ recorded after 28 days of incubation in the non-extracted, pre-dried soil. It has also reduced, though not significantly, the quantity of $\text{NO}_3\text{-N}$ produced in the fresh soil. Further experimentation will be undertaken to try to determine what type of nitrogen source is removed by the calcium sulphate extraction before incubation and whether this technique can be utilized to characterize the nitrogen status of coffee soils.

MAGNESIUM NUTRITION STUDIES

Magnesium Survey Trial

This small trial, which commenced in 1954, was continued with the modifications previously noted (6) and the first yields were recorded for a new multiple-stem cycle in 1958. Mean yields over five paired tree replications were 1.2 cwt. of clean coffee per acre from the no magnesium treatment and 1.3 cwt. from the plus magnesium treatment. Leaf samples, 1st hardened pair and 4th leaf pair on bearing primaries, were collected at monthly intervals from January to December, 1958. Statistical analysis of the analytical results revealed a marked change in the content of potassium, calcium and magnesium (as per cent in the leaf dry matter) with the time of sampling but there were no significant treatment differences.

The coffee was growing vigorously throughout the early part of the year and carried a light crop. The onset of rainfall and vegetative growth early in the year resulted in a lowering of potassium and magnesium in the leaf. The continued decrease, after the Long Rains were over in June, is ascribed to a lack of soil moisture which limited uptake of these nutrients from the soil coupled with dull weather in August and the presence of maturing crop on the tree. By September the leaf values for potassium, calcium and magnesium had increased as the crop was picked and when spasmodic rain fell from late October onwards. Vegetative growth was, however, very limited because of a failure of the Short Rains. At no time during the year were really low values found for either potassium, calcium or magnesium and the variations in leaf content of these elements followed a similar pattern to that observed in previous years' results.

Compared with the overall mean values obtained during 1957 (7) only the mean calcium figure has changed appreciably, increasing from 0.70 to 0.90%. Variations of time of sampling during the year emphasize the care necessary when interpreting leaf analysis values. The lowest values occur in the dull, cold weather of July to August when the bulk of the crop is in the latter half of the maturation period.

Manurial Trial VI

Leaf samples (4th leaf pair from bearing tertiaries) were collected from all the plots on two occasions, viz., at the end of the Long Rains period, after the coffee had flowered, set its crop and completed its growth flush, and in July when the weather was dull, vegetative growth was almost nil and the trees were carrying a large crop in the latter stages of maturation. The trees were old, mature single stem, and this was the first year of the trial. No mulch had been applied to this coffee before the commencement of the trial. Leaf potassium, calcium and magnesium variations were not related significantly to the fertilizer treatments but there was a marked and significant decrease of potassium and magnesium between the sampling dates and a significant increase of leaf calcium. Overall mean values, of 27 individual samples, were:—

Leaf potassium : May = 2.14%; July = 2.01%; L.S.D. = 0.11**

Leaf calcium : May = 1.33%; July = 1.52%; L.S.D. = 0.14***

Leaf magnesium: May = 0.33%; July = 0.30%; L.S.D. = 0.017*

Leaf potassium and magnesium were withdrawn to the maturing crop whereas the increase in the mean calcium figure is consistent with the normal accumulation in maturing leaf, in the absence of any appreciable growth. The differences between the mean values for the two sampling times follow a normal pattern. Lack of treatment differences is attributed to the fact that this was the first year of the trial and because soil applications of Kieserite and Calmag are both forms of magnesium fertilizer which are slow acting. In future years it is hoped that a greater number of leaf samples can be taken and analysed; with a closer sampling interval, more time for the soil exchangeable magnesium level to build up and with the consistent mulching treatment, differences should become apparent in the leaf analysis results.

Mulch Trial

The plots in replication I of this trial, which is now ten years old, were split for the application of magnesium fertilizer in 1957 and 1958 because of the high incidence of visible magnesium imbalance in some of the mulch treatments. Coffee leaf samples were collected from some of the plots (4th pair leaves on bearing primaries) in May and July at the same time as the samples were taken from

TABLE XLII
Leaf Potassium, Calcium and Magnesium Analysis
(% leaf dry matter)

Element	Month (January-December 1958)												Means (120)
	1	2	3	4	5	6	7	8	9	10	11	12	
Potassium a	2.79	3.48	2.78	2.82	2.36	2.04	1.90	1.84	2.06	2.13	1.94	2.05	2.35
b	(10) 3.08	3.06	2.51	2.14	2.15	2.07	2.16	1.89	2.09	2.38	2.27	2.53	2.36
L.S.D.s (10)	a = 0.18*; 0.24**, b = N.S.												
Calcium a	1.01	0.92	1.04	0.94	0.93	0.93	0.83	0.81	0.82	0.83	0.86	0.93	0.90
b	1.61	1.62	1.90	1.75	1.85	1.65	1.50	1.04	1.21	1.54	1.41	1.36	1.54
L.S.D.s (10)	a = 0.14*; 0.18**, b = 0.12*; 0.16**, 0.22												
Magnesium a	0.37	0.37	0.31	0.32	0.32	0.30	0.26	0.33	0.37	0.40	0.37	0.40	0.34
b	0.43	0.44	0.32	0.35	0.37	0.33	0.33	0.38	0.36	0.25	0.27	0.31	0.34
L.S.D.s (10)	a = 0.04*; 0.05**, b = 0.05*; 0.06**, 0.08***												
Rainfall periods							Long Rains			Short Rains			
Crop harvest period													
Main Growth periods													

a = 1st pair hardened leaves on bearing primaries.
b = 4th leaf pairs on bearing primaries.

Manurial Trial VI. The coffee in the mulch trial, however, is pruned to the multiple-stem system and 1958 was the first bearing year of a new cycle of heads. The leaf analysis results obtained for $\pm$ magnesium fertilizer application and for the simple mulch and no mulch treatments are summarized in Tables XLIII and XLIV.

TABLE XLIII
Influence of Magnesium Fertilizer on Leaf Potassium, Calcium and Magnesium
(% in leaf dry matter)

Treatment	Potassium		Calcium		Magnesium	
	May	July	May	July	May	July
+ Magnesium	2.39 (7)	1.99	1.07	0.75	0.25	0.29
— Magnesium	2.37	1.89	1.19	0.76	0.28	0.25
L.S.D.s	N.S.		N.S.		0.039*	

TABLE XLIV
Influence of Mulch Treatments $\pm$ Magnesium Fertilizer on Leaf Potassium, Calcium and Magnesium

Treatment	Potassium	Calcium	Magnesium	Yield†
No Mulch (1)	1.86 (4)	1.23	0.31	2.9(2)
Alt. inter-row Mulch—March (a)	1.97	1.23	0.34	5.3
All inter-row Mulch—March (b)	2.22	0.73	0.27	9.3
All inter-row Mulch—July (c)	2.41	0.74	0.18	9.8
L.S.D.s	N.S.	0.24*; 0.45***	0.08*; 0.11**	3.19*; 4.31**

†Yield in cwts. clean coffee per acre, 1958 crop.

The effect of the magnesium fertilizer averaged over all the mulch treatments has been at least to maintain, if not to increase slightly, the leaf magnesium content. The overall effect of mulch treatments has been to raise yields substantially and, in the case of the all inter-row applications, to increase the leaf potassium (not significant) and to decrease the leaf calcium and magnesium significantly. In fact, with the heavier mulch applications, visual evidence of magnesium imbalance was present in the trees from April/May until after the crop was harvested in December.

Later in the year, during the middle of the harvest period, samples of ripe coffee cherry were collected from these same plots and were analysed for potassium, calcium and magnesium. The results are summarized in Table XLV.

TABLE XLV
Influence of Mulch Treatments $\pm$ Magnesium Fertilizer on the Content of Potassium, Calcium and Magnesium in Ripe Cherry
(% in dry matter of cherry)

Treatment	Potassium	Calcium	Magnesium
(1)	1.86	0.25	0.10
a	1.82	0.22	0.11
b	1.91	0.19	0.13
c	1.98	0.19	0.11

For key to treatments refer to Table XLIV.

Although an insufficient number of samples was taken to enable a statistical analysis of the results to be undertaken it would seem that with the heavier mulch treatments, i.e., b and c, there has been increase in the potassium content and a decrease of calcium content. Both these differences are similar to those in the coffee leaves (refer Table XLIV). The magnesium figures, however, are the same for all treatments and this is contrary to the results of the leaf analysis in Table XLIV

but is consistent with previously published work (8). There was no apparent difference between the results for cherry samples from plots with and without applied magnesium fertilizer.

Influence of the Mulch Position on the distribution of some Plant Nutrients in the mature coffee tree

Mulch is generally laid in coffee fields in one direction for convenience of cultivation or because on sloping areas it is effective in preventing soil erosion. The recommendation to plantations is to apply an alternate inter-row mulch and to rotate that mulch annually. Thus, if the tree is considered to be growing in the centre of a square or rectangle (9' × 9' or 10' × 8' spacing) the soil on two sides of the tree will become richer in plant foods with the decomposition of each year's mulch than the soil on the other two sides. That this does, in fact, take place has been recorded for potassium, calcium and magnesium in a previous report (9).

Although it is known that the translocation of plant foods from the roots to the branches follows a spiral path upwards, and hence that plant foods from the soil on one side of a tree do not travel only to branches on the same side, an experiment was carried out to determine whether there was, in fact, any trace of a "one-sided" feeding of the tree. Certain plots in the mulch trial, the trees in which have been mulched on one or on both sides annually for ten years, were compared with no mulch plots by means of leaf samples (4th leaf pair on bearing primaries) collected at the end of the main growth period in May, 1958. Two absolute field replications were sampled and the coffee was in the first bearing year of a new multiple-stem cycle. The leaf samples were collected from four sides of the trees (referred to as North, South, East and West) and from the lower and upper halves of the trees. Equal numbers of leaf pairs were collected from each of three young heads on a tree, but the lower half of the heads always carried more crop on the primaries than the upper half did. The results are summarized in Table XLVI.

TABLE XLVI

The Effect of Mulch Position on the Potassium Calcium and Magnesium Content of the Coffee Leaf
(% of leaf dry matter)

Treatments and Elements		Position of Sample				Means
		North (No Mulch)	South (No Mulch)	East (Mulch)	West (Mulch)	
No Mulch	K.	2.23	2.19	2.26	2.04	2.18(16)
	Ca.	0.89	0.94	0.93	0.93	0.93
	Mg.	0.20	0.24	0.24	0.21	0.22
Alternate Inter-row Mulch*	K.	2.36	2.22	2.43	2.24	2.31
	Ca.	0.96	0.97	0.98	1.02	0.98
	Mg.	0.17	0.18	0.23	0.18	0.19
All inter-row Mulch†	K.	2.71	2.59	2.78	2.57	2.66
	Ca.	0.75	0.79	0.86	0.83	0.81
	Mg.	0.27	0.20	0.20	0.21	0.22
Means						L.S.D.s(12)
	K.	2.44(12)	2.33	2.49	2.29	0.14*; 0.19**
	Ca.	0.87	0.90	0.92	0.93	N.S.
	Mg.	0.21	0.21	0.23	0.20	N.S.
Position		K.	Ca.	Mg.		
Upper°		2.35(24)	0.74	0.19		
Lower		2.43	1.07	0.24		
L.S.D.s		N.S.	0.11***	0.04***		

Notes: * Mulch on the West side of the tree only.

† Mulch on the East and the West sides of the tree.

° Means for samples from upper versus lower half of the multiple-stem heads.

L.S.D.s for Treatment means of 16:

Potassium (K.) = 0.12*; 0.17**; 0.22***

Calcium (Ca.) = 0.07*; 0.10**; 0.13***

Magnesium (Mg.) = N.S.

Within the limits of the sampling technique there is no significant relationship between the position of the mulch on the soil, i.e., the position of increased plant food content in the soil, and the position of the leaf sample collected from the tree in terms of the calcium or magnesium content of the leaf. The mean leaf potassium value is significantly lower on the West side than it is on either the East or the North sides. There seems to be no logical reason for this in terms of a simple relationship between the positions of the mulch and the leaf samples, because the soil on the West side of the trees in this experiment had more mulch than any other side, i.e., both the alternate inter-row and the all-inter-row mulch treatments cover the ground on this side of the tree, yet the mean potassium figure is the lowest found. It will also be noted that the mulch treatment means, whilst not differing significantly, suggest that the more actual mulch that is applied the higher the level of leaf potassium.

Leaf magnesium figures do not differ significantly with mulch treatments, but the calcium values do, and the lower figure for the heavier mulch application could be attributed to such factors as high yield, more growth with consequently a comparatively younger leaf sample, or heavier crop requirements. A combination of causes is most likely.

What is of considerable interest, however, is the substantial difference in the calcium and magnesium values between the upper and the lower half of the tree. This apparently reflects the difference in crop and hence vegetative growth between these two parts of the young and active multiple-stem heads. It emphasizes the care which is necessary when collecting leaf samples for diagnosing mineral nutrition imbalance and during the study of nutrition in relation to crop yield and field treatments. In this instance the actual magnesium values and, more importantly, the ratios of K : Mg both serve to define a potassium magnesium imbalance, i.e., high potassium, low magnesium, but the more critical diagnosis is found with leaf samples collected from the upper half of the young multiple-stem heads.

MICRO-NUTRIENT TRIALS

Iron Chelate Trial

1958 was the second year of this trial and the last year of the old multiple-stem heads. Yields were therefore small.

The same treatments were applied as in 1957 using again the Na Fe E.E.D.T.A., 57% chelate compound (9% metallic iron) supplied by The Dow Chemical Co. of Michigan, U.S.A. The treatments were applied in early April when the coffee was growing actively and subsequently three sets of leaf samples (1st hardened leaf pair on a bearing primary) were collected at approximately monthly intervals in May, June and July.

TABLE XLVII
Mean Yields and Iron Content in Leaf Dry Matter.

<i>Treatment</i>	<i>Yield (cwt. c.c. per acre)</i>		<i>Mean Leaf Fe content over 3 samplings (ppm)</i>
	<i>1958</i>	<i>1957-58 (Mean)</i>	<i>1958</i>
(1)	2.5(6)	8.7(12)	91(18)
$\frac{1}{4}$ lb. Na Fe E.E.D.T.A.	3.9	9.7	87
$\frac{1}{2}$ lb. Na Fe E.E.D.T.A.	2.8	11.1	96
<i>Sampling Times</i>	<i>May</i>	<i>June</i>	<i>July</i>
<i>Means (18)</i>	83	55	135
<i>L.S.D.</i>	16*	22**	

Neither the yield results nor the mean leaf iron values differed significantly between the treatments but the yield results suggest that there might have been an overall response to the iron chelate treatments. There were large and significant differences in leaf iron content between sampling times; the lowest mean values were recorded in the June samples, taken at the end of the Long Rains. About five weeks later, in the early part of July when conditions were drying up rapidly, the mean leaf iron level had risen substantially. More frequent leaf sampling will be undertaken in 1959.

Zinc Chelate Trial

A trial was laid down in the Long Rains, 1958, to examine the effect of zinc chelate applications to mature single-stem coffee. Because of the limited supply of chelate material, single-tree plots were necessary and the final layout comprised six replications of three treatments; these were none (control), $\frac{1}{4}$ and $\frac{1}{2}$ lb. per tree of the Na Zn E.E.D.T.A., 55.6% chelate compound (10% metallic zinc), supplied by The Dow Chemical Co. of Michigan, U.S.A. Prior to the experiment occasional zinc chlorosis leaf symptoms had been observed in this coffee, particularly in dry weather, and leaf zinc values were considered to be low during times of rapid vegetative growth (7-12 ppm. Zn in leaf dry matter). The chelate was applied in April, 1958 (early part of the Long Rains), and after mixing with $2\frac{1}{2}$ gallons of water, it was watered on to the soil surface in a circle around each tree at a distance of between 9"-3'6" from the trunk. Two sets of leaf samples (1st pair hardened leaves on bearing tertiaries) were then collected approximately one and two months after the chelate application.

TABLE XLVIII

Mean Yield and Zinc Content in the Leaf Dry Matter

<i>Treatment</i>	<i>Yield cwt. c.c. per acre</i>	<i>Mean Leaf Zn* content over 2 samplings (ppm)</i>
(1)	1.5(6)	9.5(12)
$\frac{1}{4}$ lb. Na Zn E.E.D.T.A.	2.2	8.7
$\frac{1}{2}$ lb. Na Zn E.E.D.T.A.	2.5	8.5

* Leaf zinc analyses carried out by Mr. G. T. Chamberlain, Spectrochemist, East African Agriculture and Forestry Research Organization.

Neither the mean yields nor the mean leaf zinc results differed significantly in response to the treatments. In 1959 more frequent leaf sampling will be undertaken.

The first crop yields from the mixed chelate and Fritted trace element (glass) trial (10) will be recorded in 1959.. No additional results are available for discussion at this time.

THE MINERAL CONTENT OF RIPE COFFEE CHERRY

Samples of ripe cherry were collected at random from a field of Napier grass mulched coffee which was carrying a good crop. Visible symptoms of magnesium imbalance were noted on some of the trees from which cherry was collected. In Table XLIX an average set of analytical results for some of the elements is given for whole cherry and for some of the component parts. These figures are of interest because they allow for an approximate estimate to be made of the proportion of an element that leaves the plantation (in the parchment coffee) and of the residue that remains behind (in the skins). The mucilage is lost during the fermentation process.

TABLE XLIX

Analytical Results for Coffee Cherry

Sample	Moisture and Element Values						
	Dry Matter* lb.	H ₂ O %	N	P % in	K Dry Matter	Ca.	Mg.
Whole Cherry	2,036	69.7	1.180 (24.0)†	0.1105 (2.20)	1.93 (39.2)	0.20 (4.0)	0.12 (2.44)
Skin	560	80.8	1.118 (6.2)	0.1104 (0.60)	3.28 (18.4)	0.33 (1.8)	0.09 (0.50)
Bean	1,065	52.0	1.460 (15.6)	0.1317 (1.40)	1.45 (15.4)	0.14 (1.6)	0.19 (2.02)
Parchment + } Mucilage }	409	69-74%	0.461 (1.8)	0.0318 (0.14)	0.35 (1.4)	0.13 (0.6)	0.05 (0.20)

* Total Dry Matter in 60 cwt. of ripe cherry.

† lb. contained in 60 cwt. of ripe cherry.

The approximate distribution of the dry matter between the three major components of ripe cherry was found to be 27.5% in the skin, 52.3% in the bean and 20.1% in the parchment plus mucilage. Thus reference to the calculated values for plant nutrients shows that more than half the nitrogen (N), phosphorus (P) and magnesium (Mg) is lost from the plantation when the parchment coffee is sent into the central mills, whereas the greater portion of the potassium (K) and a fair proportion of the calcium is retained on the plantation in the skins. It is also apparent that cherry skins from mulched coffee are not a good form of organic manure to apply at heavy rates in coffee subject to magnesium deficiency and growing on a soil well supplied with available potassium, because of the high potassium : low magnesium content.

ANALYSIS OF COFFEE SOILS

Towards the end of 1958 a project was developed in collaboration with Dr. A. Mehlich (visiting I.C.A. Soil Specialist) and Mr. E. Bellis (Senior Soil Chemist), of the Scott Agricultural Laboratories, to examine the results of chemical/biological analysis of coffee soils. Soil samples have been collected from all the plots in the manurial trials and from the irrigation and other field trials on the Coffee Research Station. After statistical evaluation the results will be assessed in relation to plot treatments and yields to obtain information on possible relationships. At the same time soil samples from coffee plantations of a general nature have also been received for advisory analysis. There is, however, no information at present available upon which to base an interpretation of the soil analysis results for the purpose of advising on fertilizer (and manure) requirements of coffee in detail. The results obtained for these samples have therefore been used to check on any micronutrient deficiencies in the soils (none have so far been found) and have been viewed in relation to the known responses in coffee derived from field trial results. The data from the estate samples will also be used to compare analytical values obtained for coffee soils from different districts, particularly in the East Rift Valley area, where much of the soil is of the same type (Kikuyu dark red and red coffee loam).

Some experiments have been carried out with the biological (fungal) test method in which the growth of *Cunninghamella Blakesleeana* is measured following inoculation of the soil, after a period of two days. It has been calculated from an experiment with three absolute replications each containing paired determinations for nitrogen, phosphorus, sulphur, magnesium and potassium, that an average variation of 9% between replicates is present.

The Effect of Sample Treatment on the Biological Evaluation of Soil Nitrogen

Because of the known effect of soil drying on the subsequent mineralization of natural soil nitrogen in the Kikuyu red loam soil (5) an experiment was carried out to compare the growth of *Cunninghamella Blakesleeana* on replicated soil samples which were sub-sampled in the laboratory and incubated as (a) fresh from the field, (b) fresh field soil rapidly oven dried at 50-55°C. and (c) fresh field soil air dried over a period of six to eight weeks. Three small field plots in mature coffee, which has been shown in closely adjacent areas to respond to nitrogen fertilizer, were marked and five sets of topsoil samples (0-4") were collected between 16.12.58 and 3.2.59, i.e., a period during which the topsoil became progressively drier. The soil samples were analysed for moisture content $\text{NO}_3\text{-N}$ and $\text{NH}_3\text{-N}$, when fresh, oven dry and air dry. The fungal growth on the —N treated soils was expressed as percentage of the growth measured on the Plus All treatment, i.e., soil sample with all macro and micronutrients added, and the percentage results were then transformed (Angular Transformation) to degrees before statistical analysis.

TABLE L
Overall Mean Fungal Growth in the Absence of Added Nitrogen

Factor	Fresh Soil	Oven Dry Soil	Air Dry Soil	L.S.D.s
Growth-proportion of +All	36.0° (15) (34.5%)	34.9 (32.7%)	60.8° (76.1%)	0.7*; 16.1**
$\text{NO}_3\text{-N}$ at time of expt. (ppm)	36.00	21.3	26.9	—
$\text{NH}_3\text{-N}$ at time of expt. (ppm)	5.0	8.0	12.0	—

Note: 1. Figures in brackets are degrees converted back to percentage growth.
2. The treatment x sampling time interaction was not statistically significant.

In this experiment the fresh field soil sub-samples and the oven dried sub-samples gave equal and low results in terms of fungal growth, whereas the air dried sub-samples produced more than twice the quantity of fungal growth which was indicative of a good level of soil nitrogen availability. The mean fungal growth data for each of the five sets of samples was plotted against the $\text{NO}_3\text{-N}$ and the $\text{NH}_3\text{-N}$ soil values. No relationship could be established between fungal growth and $\text{NO}_3\text{-N}$ soil values but a highly significant and positive straight line regression relationship was found for fungal growth and $\text{NH}_3\text{-N}$ soil values. This relationship is illustrated in Figure II.

This experiment shows that the fungal growth is influenced significantly by the level of $\text{NH}_3\text{-N}$ in the soil which in turn is influenced by the treatment of the soil prior to the fungal test. Carrying this relationship a possible stage further, because the level of $\text{NH}_3\text{-N}$ in the soil varies with the soil conditions—whether wet or dry when the sample is collected from the field—it seems logical to postulate that samples of the same soil collected in the rains or at the end of a drought period will give a different reaction to the fungal test. Alternatively, it might be possible by careful pre-treatment to standardize the condition of the soil before carrying out the test.

Analysis of Soil Samples from Manurial Trial II

Soil samples were collected from the 16 plots in this trial during November, 1958. The soil is a Kikuyu dark red loam. Samples were taken at depths of 0-8" and 8-16", at right angles to the tree, i.e., in the tree-row and in the inter-row although the coffee in this trial is not mulched. Three sets of augerings were carried out in each of the 20 tree plots and were bulked, with mixing, for each depth before a final sub-sample was taken for analysis. The mean analytical data together with the mean annual yields over a nine-year period are summarized in Tables LI and LII.

FIGURE II. RELATIONSHIP BETWEEN SOIL AMMONIA AND THE GROWTH
OF CUNNINGHAMELLA BLAKESLEEANA

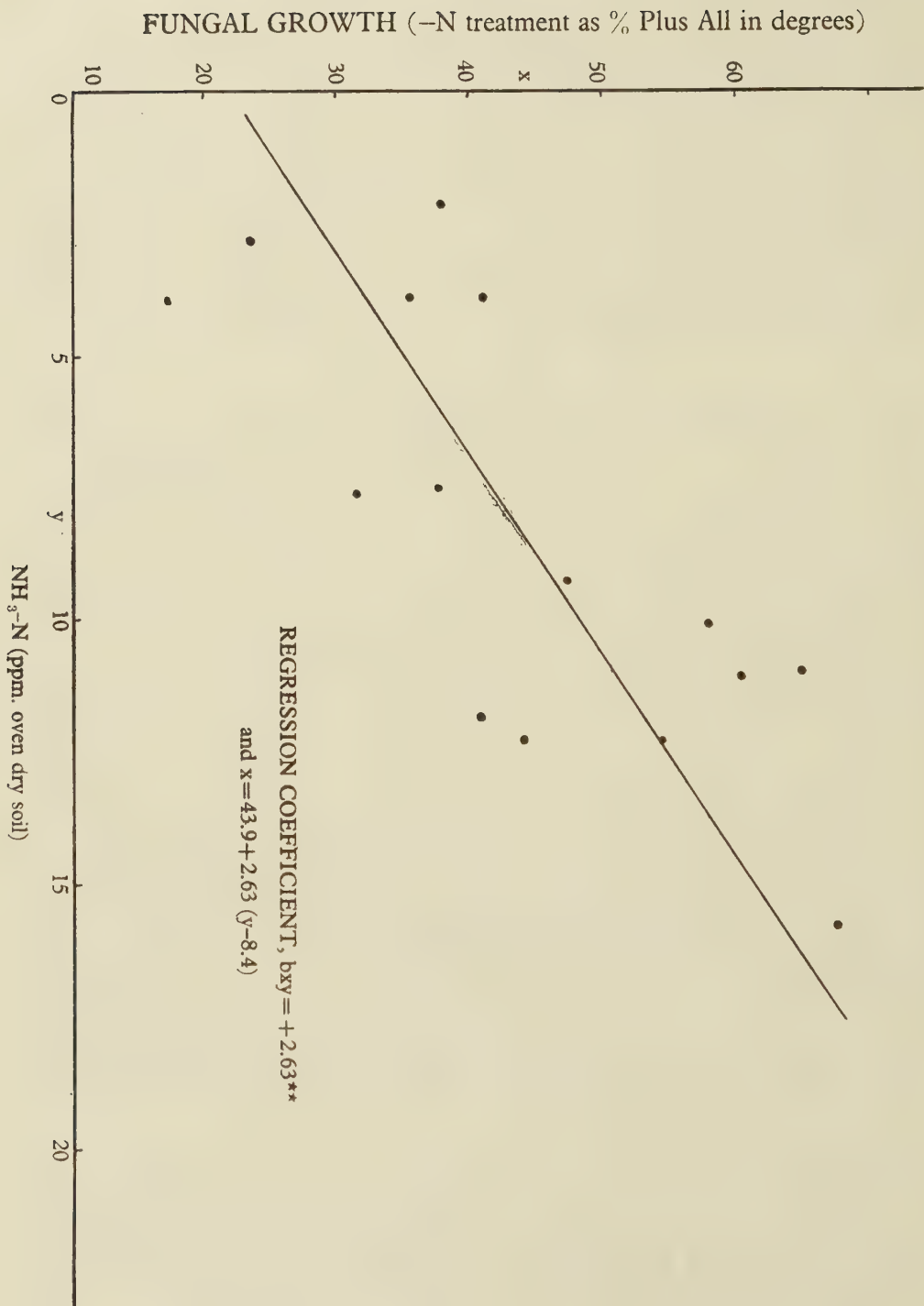


TABLE LI
Mean Chemical and Biological Soil Analysis Data for Manurial Trial II Samples

Treatment	Chemical data					Biological data				Yield ^o cwt./c.c./ acrel/ anum
	pH	K. meq. %	Ca. meq. %	Mg. meq. %	Mn. meq. %	P. ppm.	N. Deg.	P. Deg.	S. Deg.	Mg. Deg.
(1)	6.0*	1.4	7.7	3.1	0.84	15.2	17.1	29.0	56.0	63.6
6.0/6.0†		1.6/1.2	9.8/5.5	3.3/2.9	0.8/0.8	21.0/9.5	10/7.5‡	39/11	56/80	84/77
N	5.5	1.3	6.3	2.4	0.85	11.8	31.1	43.0	68.9	66.4
	5.3/5.6	1.4/1.3	2.4/5.1	2.4/2.4	0.9/0.8	16.0/7.5	29/25	54/39	77/94.5	76/90
P	5.4	1.0	4.6	2.4	0.92	16.0	25.1	46.9	69.0	67.1
	5.6/5.2	1.3/0.8	6.1/3.1	2.6/2.1	0.9/0.9	23.5/8.2	19/17	70/36	80/92.5	83/87
C	5.9	2.1	5.8	2.9	0.79	21.0	34.3	47.1	71.2	67.7
	6.0/5.8	2.9/1.8	2.5/4.2	3.4/2.5	0.8/0.8	27.7/14.2	35/29	61/46	83/94.5	82/89
NP	6.1	1.5	8.7	2.4	0.61	14.5	8.9	36.7	69.7	64.9
	5.8/6.5	1.6/1.5	9.2/8.3	2.4/2.5	0.7/0.5	18.2/10.7	2/3	64/12	86/90	72.5/90
NC	5.3	1.8	4.2	2.1	0.90	14.4	32.6	46.5	76.6	62.2
	5.3/5.4	2.1/1.5	5.3/3.1	2.3/1.9	0.9/0.9	19.7/9.0	45/15	70.5/34	91/97	77/79
PC	6.0	2.3	7.1	3.2	0.71	30.2	30.3	56.9	70.0	70.6
	6.0/6.0	2.0/2.0	9.3/4.9	3.6/2.8	0.7/0.7	44.7/15.7	46/10	88/49	86.5/90	88/90
NPC	5.6	2.3	6.0	2.4	0.82	29.6	19.7	55.4	72.0	60.0
	5.5/5.8	2.5/2.0	7.0/5.0	2.6/2.2	0.8/0.8	47.2/12.0	40/0	89/42	89/93	76/74
L.S.D.s	0.4*	0.3*	2.0*	0.5*	0.16*	7.1*	13.2*	11.6*	NS	5.9*
	0.55**	0.4**	2.7**	—	0.22**	9.5**	17.7**	15.5**	NS	—

Notes: * Mean data (of 8) for top 16" of soil and 2 absolute field replications.

† Mean data (of 4) for 0-8" and 8-16" samples as: 0-8"/8-16".

‡ Mean data (of 4) for 0-8" and 8-16", but quoted as percentage of the + all treatment.

° = Yield means are for 2 replications over 9 years (1950-1958).

N = Nitrogen and P = phosphorus fertilizers, C = cattle manure (for details see Manurial Trial II, page 8).

meq. % = Milliequivalents per 100 gms. air dry soil.

Deg. = Percentage values as degrees after Angular Transformation.

TABLE LII
Calculated Significant Effects of Fertilizer and Manure Treatments on the Chemical and Biological Soil Analyses.
Mean Analytical Effect Values

Treatment	Chemical data						Biological data				Yield Effect cwt. c.c./ acre/annum
	pH meq. %	K. meq. %	Ca. meq. %	Mg. meq. %	Mn. meq. %	P. p.p.m.	N. deg.	P. deg.	S. deg.	Mg. deg.	
N	—	—	—	0.58*	—	—	—	—	—	3.9	+1.36†
P	—	—	—	—	—	+ 7.0	7.8	+ 7.6	—	—	—0.25
C	—	— 0.76	— 1.03	—	—	* 9.5	+ 8.7	+12.6	—	—	+0.17
NP	+ 0.4	+ 0.22	+ 1.52	—	—	—	9.8	6.3	—	—	+0.06
NC	— 0.3	— 0.18	— 1.35	0.27	+ 0.33	—	—	—	—	4.1	—0.40*
PC	—	+ 0.21	—	+ 0.30	—	+ 5.28	—	—	—	—	—0.10
NPC	— 0.3	—	— 1.24	—	—	—	—	+ 5.8	—	—	—0.30
L.S.D.s	0.2*	0.13*	0.91*	0.25*	0.08*	3.6*	6.6*	5.8*	—	3.0*	0.35*
	0.3**	0.17**	1.21**	0.34**	—	4.8**	8.8**	7.7**	—	4.0**	0.52**
	0.4***	—	1.59***	—	0.10***	—	—	—	—	—	0.80***

Notes: * Mean differences of 32 determinations.
+ Mean differences for 8 plots over 9 years.

Briefly considering the figures in these two tables in comparison with data for the control (1), no treatment plots :—

1. Nitrogen fertilizer has raised the yields very significantly, made the soil more acid (lowered the pH), raised the biological nitrogen value and has decreased the magnesium content of the topsoil over all the treatments (Table LII).

2. Phosphorus fertilizer has not influenced the yield significantly, either alone or in combination with other treatments. Alone (P treatment) it has raised the biological, but not the chemical, soil phosphorus value (Table LI), whereas in combination with the other treatments, the calculated overall effect is significant for both the chemical and the biological values (Table LII). Alone it has also apparently reduced the potassium and calcium values in the samples.

3. Cattle manure has not increased the yields significantly in this trial. Alone (C treatment) it has raised the chemical and biological soil phosphorus values and the biological soil nitrogen value significantly; the overall effect of cattle manure application with and without the other treatments (Table LII) has been to raise the chemical soil potassium and phosphorus values, to reduce the chemical soil calcium value and to raise both the biological soil nitrogen and phosphorus values.

The simple overall effects of combining these treatments are many and varied, but are hardly of great practical value up to the present time since they have not influenced the coffee yields significantly. The single exception to this is the nitrogen plus cattle manure treatment, which, overall, has resulted in a negative yield interaction, i.e., the cattle manure has reduced the yield response to nitrogen fertilizer. This treatment has directly reduced the soil pH, the chemical soil calcium and soil magnesium values and has raised the biological nitrogen and phosphorus figures significantly. Overall, the effect has been to reduce significantly soil pH and the chemical potassium, calcium and magnesium values and to increase the chemical soil manganese figure.

In terms of a relationship between the soil analysis and economic fertilizer use on the coffee in this trial, it can be stated that the biological nitrogen value of 10.0/7.5% for the 0-8" and 8-16" soil samples from the control plot indicate a level at which a response to nitrogen fertilizer will be obtained. Visible magnesium deficiency (imbalance) symptoms have been observed in the older leaves of bearing tertiaries in this trial which suggests that either the level of magnesium in the control treatment, and all the other treatments as well, is too low or that the ratio of exchangeable soil magnesium to potassium is too narrow. It might also be postulated that, with the exception of the biological nitrogen for the control treatment, all the lowest analytical values in Table LI represent an adequate level for crop production in this trial though this is subject to the results of more intensive study in the future.

The Influence of Mulch on Soil pH, Organic Carbon and Total Nitrogen

In a previous Annual Report of the Coffee Research Services (2) a contrast was made between the two replications of Experiment No. 1 in terms of soil moisture ammonia and nitrate nitrogen. Prior to the experiment commencing in 1956, replication I (R.I.) had been weed-free bare fallow for five years, whereas replication VI (R.VI) had been weed-free Napier grass mulched fallow for the same period of time. Soil samples taken in this experiment between 23.3.56-6.1.58, from the no mulch, stone mulch and Napier grass mulch treatments, were selected and analysed for pH, total nitrogen and organic carbon content (the latter is a measure of soil organic matter). Results were examined in relation to the three treatments and to the mean values for R.I and R.VI.

TABLE LIII
Summary of Results: pH, Total Nitrogen and Organic Carbon

	pH.	Tot. N*	Organic C*
R.I. Bare Fallow	4.8 (63)	1.39	16.77
R.VI. N.G. Mulch†	5.3	1.58	19.44
L.S.D.s	0.3*	0.21**	2.64***
(1)	5.0 (42)	1.45	17.74
Stone Mulch	5.1	1.49	18.34
Napier grass Mulch	5.1	1.52	18.05

*=Milligrammes per gramme of air dry soil.

†=Napier grass mulch.

The residual influence of five years Napier grass mulch is still apparent in the higher pH, total nitrogen and organic carbon figures. Contrasting the overall mean values for the three treatments there is very little difference in pH and small but non-significant differences between the total nitrogen and organic carbon figures in favour of the stone mulch (inert soil cover) and the Napier grass mulch. Significant and positive straight line regression relationships were found between organic carbon and total nitrogen; whilst the relationships were very similar for the no mulch and stone mulch treatments, the relationship for the Napier grass treatment was different and reflected the addition of organic matter to the soil during decomposition of the mulch.

Using the copper technique of Lees (11), it was shown that the proportion of inactive organic matter decreased with soil sample depth.

TABLE LIV
Variation of Inactive Organic Carbon with Sample Depth

<i>Depth</i>	<i>Inactive Organic Carbon*</i>	<i>Total Organic Carbon*</i>	<i>% Inactive Carbon</i>
0—3"	6.2 (42)	20.18	30.7
3—6"	3.1	18.21	17.0
6—12"	2.2	15.93	13.8

* = Milligrammes per gramme of air dry soil.

From the analysis results for all the soil samples irrespective of mulch treatments, highly significant and positive straight line regression relationships were found between the adsorbed copper (milligrammes per gramme of air dry soil) and the organic carbon data for each sample depth. From these equations the values for inactive organic carbon, as a part of the whole, were calculated for each depth and it was shown that this value decreases with the increase in soil depth. Conversely, the proportion of the total soil organic matter that is active in terms of copper adsorption was shown to increase with soil depth quite appreciably.

It was also found that there was a greater proportion of active soil organic matter in the Napier grass mulch treatment than in the no mulch treatment; as much as one-quarter to one-third more copper was adsorbed by the soil mulched with Napier grass during the period of the experiment.

CULTIVATION AND CROPPING OF VLEI SOILS

A full and detailed report of the original trial laid down in 1954, in terms of crop yield results up to the end of 1957 and modifications to the cultivation system, has been published (12, 13).

Because of unseasonal rain, subsoil cultivation between the Napier grass rows for the purpose of soil structure regeneration, although desirable, was not possible in the pre-Long Rains 1958 period. Yields in the first 1958 crop were therefore low despite the heavy Long Rains. The failure of the Short Rains combined with the loss of soil structure in the beds resulted in very low yields from the second crop and no significant differences were found between treatments. The necessary sub-soil cultivation was completed in the early part of 1959 quite satisfactorily. A summary of the 1958 results is given in Table LV.

TABLE LV
Napier Grass Yields and Treatment Effects.
(Tons per acre)

Treatment	Yield				Treatment Effects	
	L.R.†		S.R.†		L.R.	S.R.
	A‡	B‡	A	B	B	B
(1)	5.50(3)	1.19	0.86	0.26	—	—
N.	4.33	0.94	0.70	0.21	+0.42	—
P.	7.12	1.54	0.90	0.27	+0.92	—
C††	12.55	2.72	1.47	0.44	+1.35	—
N.P.	12.74	2.76	1.16	0.35	+0.68	—
N.C.	11.32	2.46	1.56	0.47	—	—
P.C.	13.09	2.84	1.24	0.37	—	—
N.P.C.	17.67	3.83	1.25	0.37	—	—
L.S.D.s	2.70*	0.59*	Not Sig.		0.38*	—
	3.75**	0.81**			0.53**	—
	5.21***	1.13***			0.78***	—

† L.R.=Long Rains 1958. S.R.=Short Rains 1958.

‡ A=Green Matter. B=Dry Matter.

††=Cattle manure applied 1957. Next application 1959.

The responses to treatments confirm the conclusions drawn and the recommendations for fertilizer and manure treatment previously made, viz., that either ammonium sulphate and double superphosphate, each at 1 cwt. per acre, or cattle manure at the rate of ten tons per acre broadcast in alternate years over the bed surface, should be applied in the early Long Rains and pre-Long Rains respectively. For optimum yields both of these recommendations should be carried out. Urea at 50 lb. per acre can be substituted for ammonium sulphate.

A further vlel area on the Coffee Research Station has been put under Camber Beds for a variety of purposes. Records of water run off in relation to rainfall quantity and intensity were kept and have been reported for 30-ft.-wide beds (13), the performance of crops grown on various widths of bed from 12 ft. to 48 ft. is being recorded and the comparison of a number of new potential mulch grass species is also being undertaken.

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PLANT PHYSIOLOGY

GROWTH RECORDING TRIALS

The growth pattern at the Coffee Research Station followed very closely that of the rainfall figures. As usual, the rainfall in February appeared to cause the maximum response in March and, although there was much heavier rain in May, the growth impetus did not increase but continued to decline to its nadir in September.

The sparse Short Rains were reflected in the delayed growth response, for, where in normal years the maximum growth is in November, in 1958 it did not manifest itself until December, reaching a minor peak at the end of January, 1959—usually a time of little increase.

All treatments showed practically uniform rates of growth, with the irrigated trees showing a slight advantage in the January/February, 1959, period after the poor rainfall experienced from August onward. Doubtless this additional moisture will exert effect increasingly if 1959 proves a “dry” year.

The weight of cherry from single-stem trees was double that from multiple-stem and the shaded multiple-stem bore less than any other trees—presumably because their rapid elongation lessened the pruning cycle to two years. Conversely, the shaded single-stem trees bore more crop than the unshaded. Irrigation had no effect on the yield, but this should become evident in the 1960 crop year if the rainfall returns to normal in 1959.

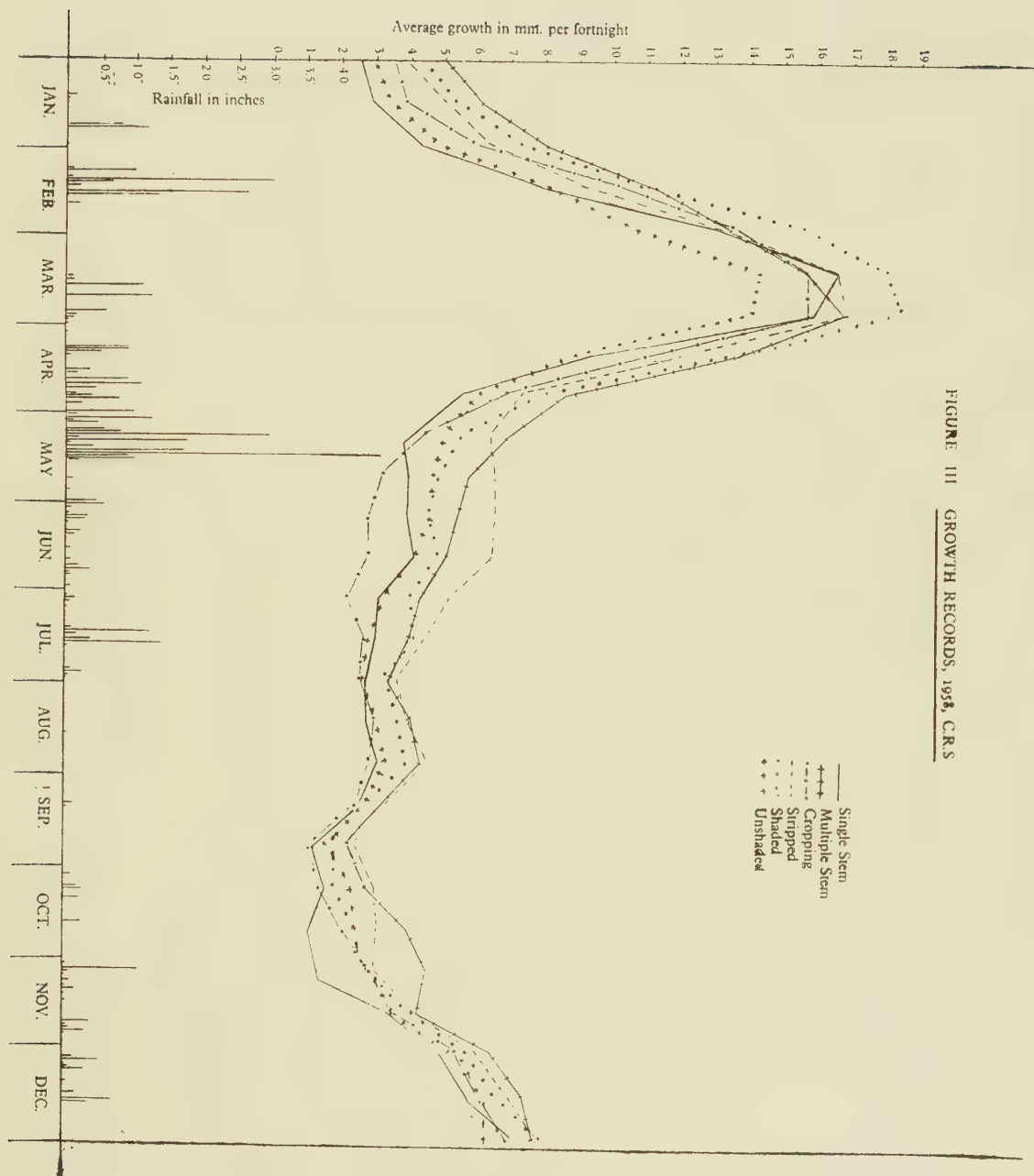
At the Scott Agricultural Laboratories, throughout the year the growth of the multiple-stem trees exceeded that of single-stem, but all treatments followed the same growth pattern of a maximum in March, resulting from the heavy February rainfall, falling to a minimum in July and rising to a peak again in October. This last growth was extraordinary since there was practically no rain preceding the flush, and it ended quickly with a decrease by the beginning of November. Rain during November caused a second comparable peak in December which, however, fell off rapidly in spite of rainfall in that month.

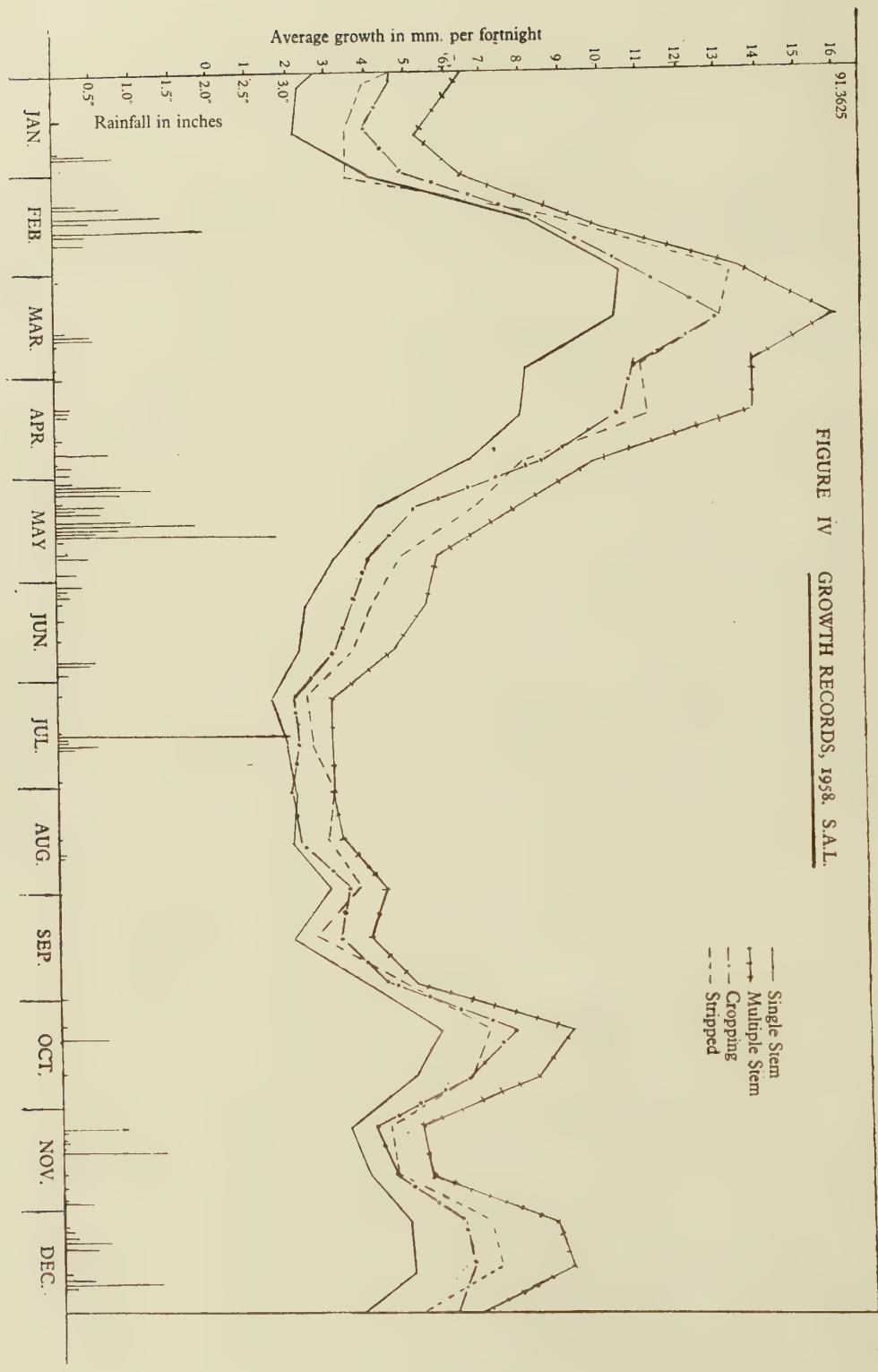
The presence or absence of crop had little effect on the growth throughout the year.

TABLE LVI
GROWTH RECORDING C.R.S. 1958
Yield corrected for cwt./acre of clean coffee

	<i>Unshaded</i>		<i>Shaded</i>		<i>Means</i>
	<i>Unwatered</i>	<i>Watered</i>	<i>Unwatered</i>	<i>Watered</i>	
Single	19.71	20.95	23.56	26.57	22.70
Multi	11.99	12.98	11.48	8.92	11.34
Means	15.85	16.97	17.52	17.75	
	16.41		17.64		

FIGURE III GROWTH RECORDS, 1958, C.R.S

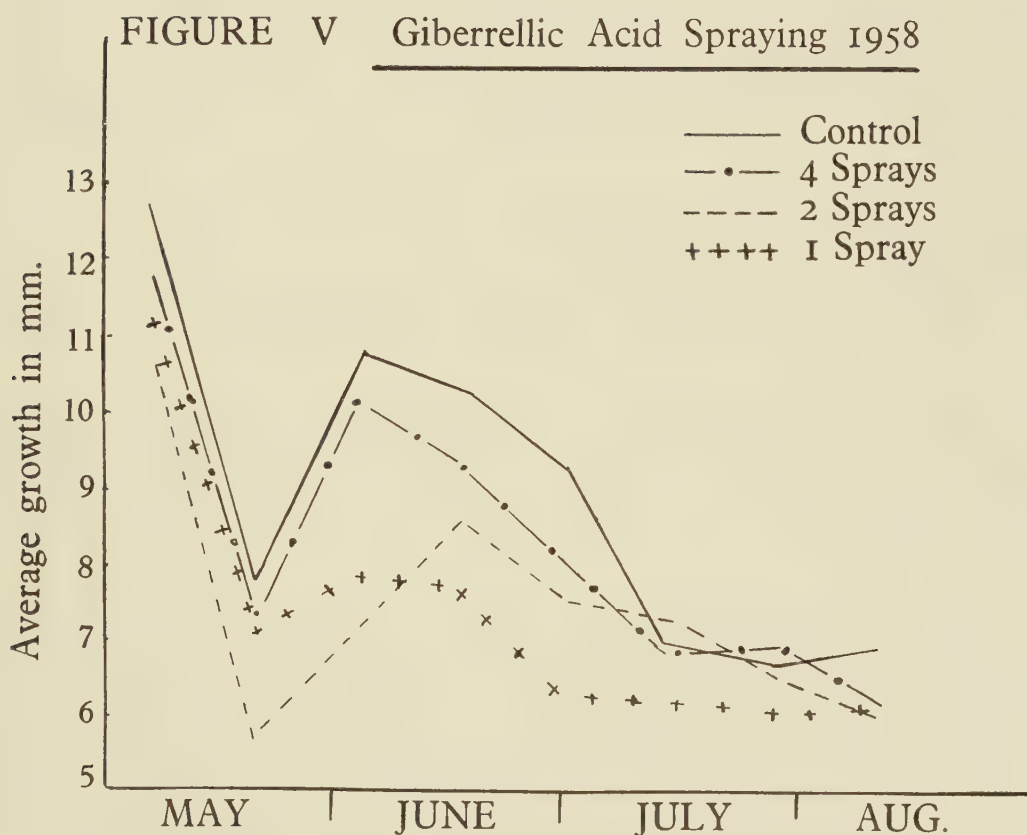




Giberrellic Acid Test

A small trial was arranged to examine the effect of spraying branches on mature trees with Giberrellic Acid. A concentration of 100 ppm. at the rate of $\frac{1}{2}$ pint per tree was applied by a hand sprayer first on April 23, 1958. In each block there was a control, the other plots receiving respectively one, two and four applications of Giberrellic Acid at fortnightly intervals.

Growth was recorded at two-weekly intervals for three months on four branches of each tree. From the graph of the growth increases it can be seen that the control trees achieved more growth than the treated ones except towards the end of the period when all were slowing down. It seemed, therefore, that the Giberrellic Acid had no effect in the prevailing conditions of the test.



PLANT PATHOLOGY

Leaf Rust

Although 1958 was another year of considerable rainfall, most of it fell in the first seven months, while the Short Rains were very light. In consequence the incidence of *Hemileia vastatrix* dropped to a low level by the end of the year in contrast to 1957, but the pre-Short Rains spray was a wise precaution to prevent a "build-up" in the "Infective Periods" through October, November and December, although the dry period of July/August had prevented much carry-over of infection from the Long Rains.

There are now well-tested collections of coffee varieties which react differentially to the strains of *Hemileia vastatrix* endemic in Kenya. Race II is found in all districts of the Colony and affects the Bourbon trees found in most established plantations, but cannot live in the Kent Selections, such as S.L.6. As the result of many tests it is established that Race I is endemic in the Teita, Meru, Elgon and North and South Nyanza Districts, where it flourishes in the hot and humid atmosphere of the lower altitudes. Clones of resistant strains from India are now growing in quarantine and seedlings from the same source are in station nurseries. If these flourish in the Kenya climate they should be invaluable, since they are immune to Race I, although Dr. d'Oliveira has found that Race VII, to which they are susceptible, is present in South Nyanza. Repeated testing in Kenya has failed to isolate Race VII, however. Two selections, made by Dr. Sylvain in Ethiopia, which have shown immunity to all races of the fungus, are due to be tested under local conditions in Kenya.

Germination Tests

Spores of Races I and II of *Hemileia vastatrix* have been germinated in "hanging drops" under many differing conditions, from which the following conclusions have resulted:—

Exposure to strong sunlight kills spores in 48 hours or less.

The usual period during which spores remain viable is between three and four weeks.

Complete darkness is not a necessity—subdued light is efficacious for both storage and germination. This could become an important factor where coffee is heavily shaded.

An Experiment to Test the Time of Application of Sprays

The results of this experiment showed that control of rust exerted by each spray application lasted about four months, after which there was a sharp decline in effect. As this timing appeared to remain constant, irrespective of the weather, an experiment has been initiated with sprays applied at three-monthly intervals based on the anti-leaf-fall application in May, the timing of which has been established by previous tests. The first sprays have been applied and monthly rust counts are being recorded.

An Experiment to Compare the Value of Seven Fungicides

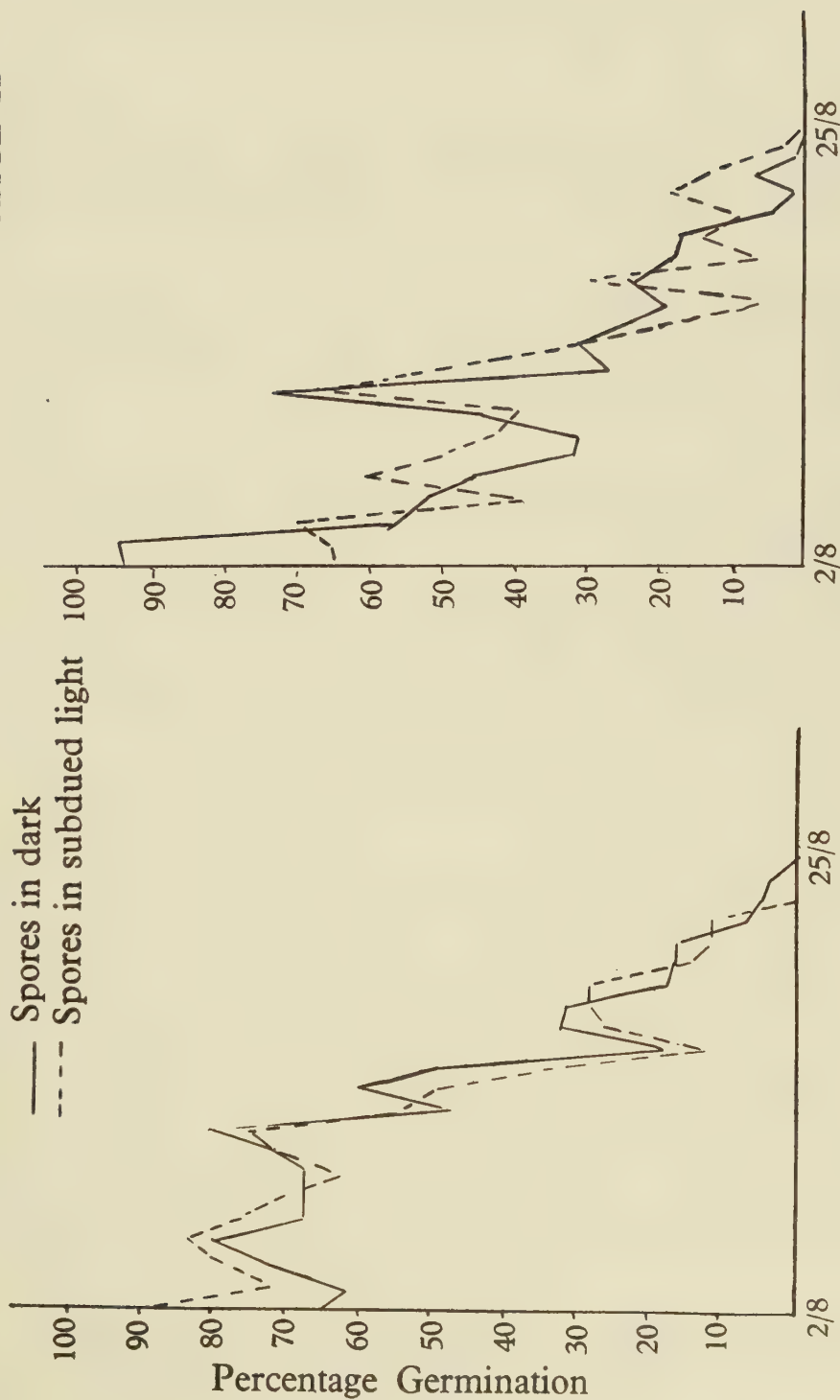
Three blocks, each consisting of eight lines of 20 trees, were sprayed with seven different fungicides, leaving an unsprayed control line in each block. A year's programme of spraying, including the anti-*Hemileia* and anti-leaf-fall applications, began with the "pre-Short Rains" spray in October, 1958. Monthly rust counts are being maintained so that the level of control can be assessed throughout the year. Colloidal copper has shown the best control initially while the organic compound has not done so well. There have been six monthly rust counts to date and the colloidal copper has proved very successful, maintaining a high degree of rust control throughout. An organic compound has proved comparable with an oxychloride while mineral oil and a cuprous oxide have risen from a low level to a high position. The relative efficiency during the Long Rains will be a good test of the various compounds involved.

Preliminary Testing of Copper Fungicides

The number of proprietary copper fungicides increases at such a rate that a simple means of assessing the properties of each new product is needed. On the assumption that solubility and precipitation are factors related to fungicidal value, all copper fungicides available locally have been tested in the following manner:—

FIGURE VI GERMINATION OF HEMILEIA SPORES

RACE II



Weighed amounts of fungicides are mixed in the appropriate volumes of water and allowed to settle. Note is taken of the relative speeds of precipitation and the condition of the fluid. Chemical assays of the amount of copper remaining in the supernatant fluid have been made, showing great differences between the samples.

Copper Dusting

As a new oxychloride dust has been produced which is extremely finely ground this is being tested at the rate of 10 lb. per acre, with rust counts every month to record the level of infection. If this fungicide proves effective it will go far to solve the problems in districts where water is scarce or distant from the plantation. Previously copper dusts have been found unsatisfactory—mainly because the material was of too coarse a texture to cling to the surface of the leaf.

Spraying Machines

In co-operation with the Agricultural Officer (Investigations) the Micron and Master Sprayers were compared with the Eclipse Warley hand-sprayer. When assessed by chemical assays, rubeanic acid prints and subsequent control of Rust infection the two tractor-drawn machines were equally effective, although the Master used several times the volume of spray applied by the Micron. The hand-sprayer was undoubtedly better than either.

Overhead Irrigation

The effects of overhead irrigation on copper fungicide cover were estimated by sample leaves, taken from trees which had been sprayed, before and after irrigation. Rubeanic prints showed that the fungicide deposit had been favourably redistributed. It is assumed that the irrigation water had washed the deposit from the upper surface of the foliage to the lower surfaces of the same or adjacent leaves.

Percentage cover after spraying 6.6%

Percentage cover after spraying and irrigation 18.7%

A drawback to overhead irrigation is the risk of moisture on the leaves before nightfall, giving rise to artificial “infective periods”, when Rust spores can germinate and invade the leaf.

ENTOMOLOGY

General Pest Situation

The most important pest in all areas was the Leaf Miner. Lace Bug and *Antestia* were next in importance. There were more localized but serious attacks of Tip Borer, Thrips, Yellow-headed Borer, Brown Scale, White Waxy Scale, Mealybug, Berry Moth and various leaf-eating caterpillars, especially *Parasa vivida* Walk., *Niphadolepis alianta* Karsch. and *Epiplema dohertyi* Warr. These various outbreaks are discussed in more detail below.

Research Programme

The pests having the highest priority in the research programme are Leaf Miner and the Tip Borer *Eucosma*. There was no Entomologist for the period May to September, 1958. From October to December, while there was a heavy field infestation, work was concentrated on the Leaf Miners. From the beginning of 1959 the emphasis was transferred to the Tip Borer.

The short-term objective of the insecticide work is to find a general-purpose, reasonably cheap, non-persistent insecticide of low mammalian toxicity to replace Malathion, Parathion and Diazinon. Longer-term objectives are:—

- (a) The increased use of Pyrethrum sprays. This is the foliage spray considered least likely to kill large numbers of beneficial insects. The ovicidal properties of Pyrethrum were reported some years ago (1) but have been little exploited in economic entomology. There seems to be a good chance that they may be put to practical use against Kenya coffee pests. Progress on these lines is reported under *Antestia*, Leaf Miner and Tip Borer;
- (b) The increased use of persistent insecticides but not as foliage sprays. Dieldrin banding is already used for the indirect control of mealybugs. Persistent insecticides applied to the soil or the trunks of coffee or shade trees show promise of indirectly controlling Tip Borer and Thrips.

Other facets of the insecticide work are:—

- (a) Trials of new insecticides against occasionally serious pests, especially Brown, White Waxy and Star Scales. Present recommendations for the control of these pests are not wholly satisfactory;
- (b) Trials to find out if any of the new insecticides give rise to undesirable flavours in the coffee liquor;
- (c) Work in co-operation with the Colonial Pesticides Research Unit at Arusha to find out the persistence of toxic residues after spraying with Parathion.

Leaf Miner. *Leucoptera* spp.

Damage by the Leaf Miners *L. meyricki* Ghes., and to a lesser extent *L. coffeina* Washb., was widespread and severe, especially from the end of the Long Rains in May to mid-December. Malathion was used to kill the moths, Parathion or Diazinon to kill the caterpillars in the mines.

Preliminary laboratory tests showed that *L. meyricki* eggs can be killed with an aqueous spray containing 0.01% Pyrethrins. Experiments were done to find a larvicide less poisonous to man than Parathion and effective at lower concentrations than Diazinon. Rogor and the Murphy insecticides M.C. 7 and M.C. 47 showed some promise, but further tests are required. Metasystox and Phosphamidon were disappointing. In a small-scale trial pairs of leaves were chosen, each on the same node of a primary and each with an unopened mine less than 1 cm. in length. One of each pair was painted on its upper surface with 0.15% Diazinon. Painted leaves were retained by the coffee bush significantly longer than unpainted leaves. Overhead irrigation caused a (corrected) larval mortality of 26% in a field infestation with mines of all ages. Ground-irrigated trees were used as controls. Most of the larvae remaining in mines with an exit hole were drowned.

A collection of larval and pupal parasites representing all areas of Kenya and all times of the year was begun. It is hoped that other parts of Africa may have parasites which can be usefully introduced into Kenya. The full range of the local complex is not yet fully known, however.

Berry Moth. *Thliptoceras octoguttale* Feld.

In the latter part of 1958 this pest caused severe damage on estates in Makuyu. In other districts it is more often beneficial, destroying a few clusters of cherry on an overbearing primary. Since work on the biology and control of this pest is in progress in Tanganyika, work in Kenya was confined to:—

- (a) A spray trial at Makuyu. This gave inconclusive results due to a low infestation;
(b) Routine trapping of moths on the Makuyu Substation to gain information on their seasonal activity.

Tip Borer. *Eucosma nereidopa* Meyr.

This pest caused severe damage to sucker tips on estates in Upper Kiambu in the early stages of a multiple-stem pruning cycle. Damage to cherries and the tips of shoots was less important.

Life history studies have revealed a number of points where control measures may be usefully employed.

Egg. Caged moths, in the absence of vegetation, will lay their eggs on certain types of frosted glass. An aqueous spray containing 0.01% Pyrethrins and sprayed at the rate of 1 ml. to 112 sq. cm. of glass surface gave 100% kill of eggs in preliminary tests.

Larva. A larva frequently attacks the side shoot of a sucker where it does relatively little harm but, after a week or two, leaves the side shoot and attacks the main shoot. An experiment to find out if a useful measure of control can be achieved by cutting off freshly wilted side shoots is in progress.

Attempts to kill the tunnelling larvae with sprays of systemic insecticides gave no significant measure of control. The following were tried: Rogor (0.1% a.i.), Phosphamidon (0.02% a.i.), Metasystox (0.05%), Thiodan (0.2% a.i.) and Sevin (0.1% a.i.).

Studies of sucker growth are being made. It is possible that at certain times of the year a satisfactory deposit of a persistent insecticide can be maintained long enough to kill newly-hatched larvae and older larvae migrating to fresh positions on the sucker.

A particularly vulnerable point in the life history is when the mature larvae leaves the berry, shoot or sucker and seeks pupation quarters on the trunk of the coffee bush. The distribution of pupae on the trunk is reported to be as follows (McCrae, unpublished): 0-18" 58%; 18-36" 31%; 36-54" 11%.

Some control of the Codling Moth, a pest with somewhat similar pupation habits, has been achieved in America (2) by spraying the bark with Parathion. A similar approach is being tried on an estate in Upper Kiambu. The bark from ground level to 3' was sprayed to run off with 0.16, 0.08, 0.04 and 0.02% a.i. Parathion. Plots consist of four trees only to avoid killing large numbers of moths and complicating the assessment of results. First counts are encouraging but the full period for which the various deposits are biologically available is not yet known.

Pupa. The possibility that pupae can be killed by spraying with Tar Oil has not yet been investigated. It has been shown, however, that spraying the bark with 5% Tar Oil has no ill-effect on the coffee bush (apart from scorching soft leaves or any suckers that may be present). Tar Oil has been included in this season's taint trial.

Adult. The moth flies chiefly at night. In the daytime it is to be seen on the trunks of shade and coffee trees. Counts were made to find out:—

- (a) The relative proportion of moths on the two types of trees;
(b) The distribution of moths on the shade trees.

Results were rather variable, depending on the height of the coffee and prevailing weather conditions. Two conclusions have emerged, however. First, as many as 28% of the moths can be found on shade trees even though there are only about 20 shade trees and 500 coffee trees to an acre. Second, more than 95% of the moths on the shade trees are found between ground level and the height of the surrounding coffee. Most are found between 1' and 4' from the ground.

Work in Tanganyika (3) has shown that if 2% D.D.T. is sprayed on to coffee bark there remains a surface deposit of more than 100 mg. D.D.T./sq. ft. for approximately 30 weeks. Laboratory assays indicate that such a deposit would kill *Eucosma* moths. Field trials to test the effective persistence of 2% and other concentrations of D.D.T. on the bark of *Grevillea robusta* trees are now in progress. If deposits on the bark of this shade tree behave in the same way as deposits on coffee bark then spraying the shade trees alone might be expected to give a large measure of *Eucosma* control.

Observations on caged moths indicate that there is a pre-oviposition period of five days and the moth lives about three weeks. These figures require confirmation.

Light traps according to the design of Weber (4) have been made for checking the seasonal activity of the moths.

Antestia. *Antestiopsis lineaticollis* (Stål.)

There were, as usual, outbreaks in all areas of this pest, especially on estates where routine testing was neglected.

Using a cage designed by Geering (5) for Cotton Stainer breeding, a successful culture of *Antestia* was maintained in the laboratory. Adequate moisture for the first instar, frequent changes of food and scrupulous cleanliness are all that is apparently required for success.

Research at laboratories of the Pyrethrum Board of Kenya has shown that a spray of 0.005% Pyrethrins is sufficient to give a 100% kill of *Antestia*. Nevertheless, in field trials 0.05% sprays have frequently given poor control. Similar discrepancies occur with dust formulations. E. Green, on the basis of her (unpublished) observations, suggested that, in the field, some of the *Antestia* were being knocked down before receiving a lethal dose. When they returned to the tree the Pyrethrins had already been largely destroyed by sunlight. A small experiment to test this theory was done at the Coffee Research Station. The insecticide used was a 0.3% Pyrethrins dust. Plots were single trees from which all *Antestia* were carefully removed by hand. On the day before dusting the trees were infested with a known number of fifth instar nymphs. Total knockdown in this experiment was shown to be 95% but total kill, if insecticide was applied just to the foliage, was only 72%. Work on the minimum concentrations necessary for adequate knockdown and on soil or trunk treatments to prevent the bugs returning to the foliage is in progress.

Sample gelatine capsules were received from the Pyrethrum Board containing sufficient Pyrethrum extract for two pints of kerosene for routine *Antestia* testing. This mixture was tested and found fully equal to the standard "double-strength" extract used for so many years and a good deal more convenient to prepare. It is hoped that capsules of this type will soon be on sale to planters.

Lace Bug. *Habrochila ghesquierei* Schout.

This pest continues to spread in the East Rift areas, reaching Makuyu by the end of 1958. Some planters found it necessary to spray with Malathion or Parathion but on most estates the mirid predator *Stethoconus* sp. kept the pest in check. Two sprays, one 21 days after the first, were recommended (6). Control has proved expensive when rain or other difficulty has prevented exact timing of the second spray.

Yellow-Headed Borer. *Dirphya* spp.

A serious outbreak of *D. nigricornis* (01.) occurred on a few estates in the Thika district. In some blocks of the worst-affected estate more than 90% of the trees have been attacked and up to 16 larvæ have been found in a single head of a multiple-stem tree. No parasites have yet bred out in the laboratory or have been found by dissecting larvae. Fumigation with an Ethylene Dichloride/Carbon Tetrachloride mixture has given the best control. Clean weeding appears to be essential in bad outbreaks so that frass from tunnels overlooked in the first round of treatment can be easily detected during the second round. When the larva is active it throws out frass twice or more a day. Young larvae can be destroyed by cutting off the wilted tips of branches.

There have been sporadic attacks of borer in other parts of Kenya (probably *D. princeps* (Jord.)) but in each case only a few trees were affected.

White Borer. *Anthores leuconotus* Pasc.

Using the control measures developed in Tanganyika, all mature trees in the Makuyu—Mitubiri area were sprayed with $\frac{1}{2}$ % Dieldrin on the lower 18" of the trunk in March and October, 1958. During April, 1959, a total of 2,500 trees from ten different estates were inspected for signs of active larvæ. Only eight infected trees were found.

Thrips. *Diarthrothrips coffeae* Williams.

The thrips season was very prolonged this year and, though few estates had very high numbers, the cumulative effect of more than four months' damage was considerable.

Populations of the active stages were reduced to 30%—40% of the controls by spraying the ground with Aldrin (four pints of 24.5% E.C. per acre) or Dieldrin (five pints of the 18.6% E.C. per acre). This degree of control has already lasted three months and may well last much longer. Unfortunately the experimental area has only had a relatively light thrips attack, rarely exceeding a mean of two per leaf, so the efficacy of soil treatments during a severe attack remains in doubt. Normal cultivation treatments have not appeared to interfere with the control.

Regular weekly thrips counts, using the method described by Le Pelley (7), have been made at the Coffee Research Station since 1948. Attempts were made to correlate these figures with temperature records as described by Notley (8, 9). Though in some years there is an excellent correlation

between mean maximum temperatures and adult thrips number one month later, in other years the temperature rises without any corresponding increase in thrips. This is possibly due to excessive or inadequate soil moisture (10) affecting the viability of the pupal stages. Attempts to predict from rainfall and soil moisture records when limiting conditions are likely to prevail have not so far proved successful.

Scale Insects

Heavy infestations of the Brown Scale *Saissetia coffeae* (Walker) and the White Waxy Scale *Ceroplastes luteolus* De Lotto occurred on some estates. On most the attack was cleaned up by parasites and predators without the trees receiving more than a temporary setback. A wide range of organo-phosphorus insecticides was tried against these pests both alone and with 2% Alboleum. None offered any prospect of an economic control of *Ceroplastes*. Gusathion at 0.04% a.i. gave an excellent control of *Saissetia*, killing all stages except the fully-rounded female and eggs and nymphs still protected by the maternal carapace.

The bark-dwelling Star Scale *Asterolecanium coffeae* Newst. appears to be increasing in severity in the Thika district. It is possible that Dieldrin-banding for ant control is killing ladybirds such as *Chilocorus angolensis* Crotch. as they search the bark for young scales. Dipping infested branches in 5% Tar Oil gave 100% kill of the eggs of this scale in laboratory tests but spraying the bark in the field gave disappointing results. Experiments to investigate this discrepancy are planned.

Mealybugs

There were serious attacks of the Common Coffee Mealybug *Planococcus kenyae* Le Pelley in Makuyu even in the absence of attendant *Pheidole* ants. Pressure sprays of 0.025% Diazinon appeared to give good control though no formal trials were undertaken.

The common Root Mealybug in the East Rift areas of Kenya is *Planococcus citri* Risso. It is not usually ant-attended. Attempts to control it with soil applications of Phosdrin and foliage sprays of various systemic insecticides have all failed. Fortunately only a few trees in a block are usually affected.

Mites

The distortion of young leaves and the formation of corky patches on their undersides is usually attributed to mite damage, since the symptoms resemble those described by Tapley (11) on Tanganyika coffee. However, only two phytophagous species have to date been found in quantities on Kenya coffee. A red Phytotpalpid, probably *Brevipalpus phoenicis* (Gheijsskes), was caged in large numbers on leaves of various ages but no distortion or suberization resulted. The possibility that damage due to other causes is aggravated by the feeding of this mite is being investigated. It is usually abundant on corky leaves and berries. A Tetranychid, not yet identified, has been found feeding in large numbers on the upper sides of mature leaves on a few trees at Ruirui.

Taints

Taints were reported from coffee liquor prepared from the crop of trees sprayed with Phosphamidon, Rogor, Sevin and Toxaphene. However, these taints were described as "slight" or "very slight" and no particular off-flavour was specified. Past experience suggests that such taints are unlikely to be of economic importance, but the trial will be repeated. Metasystox and Endrin sprays did not give rise to a taint.

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RESEARCH INTO THE MECHANICAL DRYING OF ARABICA COFFEE

Mr. J. F. McCloy, Senior Scientific Officer, East African Industrial Research Organization, continued work on the problem of coffee drying assisted by Mr. C. Gough, Assistant Agricultural Officer (Coffee Processing). The following report is extracted from the East African Industrial Research Organization Annual Report.

Previous work having shown that the severe damage to the raw appearance of wet processed arabica coffee caused by machine drying was due to the absence of sunlight, the first part of the season's work was directed to isolating the frequencies responsible for this effect.

Having prepared a large sample of dry coffee, deliberately damaged by machine drying in darkness, nine repeat tests were made by exposing samples under coloured Perspex filters using both sunlight and fluorescent tubes as radiation sources. The results indicated that recovery in colour was associated with the blue region of the visible spectrum and accordingly a set of seven Chance-Pilkington shortwave cut-off filters, covering the visible spectrum in uniform steps, was obtained.

Again using both sun and fluorescent tube sources, it was confirmed that the frequencies most active in promoting the required bean colour development during drying lay in the blue region at around 4600 Angstrom.

Further results obtained by drying beans under the radiation from "Blue Actinic" tubes, having a continuous spectrum peak at 4100 Angstrom, substantiated earlier findings that the effect of ultra-violet radiation is confined to yellowing of the parchment and does not affect the commercial value of the beans themselves. The disappointing results already obtained with high-pressure mercury vapour lamps and the very poor results obtained with sodium lamps are probably explained by the absence of strong emission from these sources at the frequencies indicated for maximum bean response.

The chance of producing an economical "artificial sun" drier now appearing to be remote, further study of the photosensitive phenomena was abandoned in favour of work on the storage properties of coffee at various moisture contents from fully wet (54 %) to black stage (25% to 15%). Several findings have emerged.

The serious defect of "onion" flavour has been shown to develop only in fully wet coffee and the intensity of the flavour is directly related to the total time elapsed from the start of fermentation to the end of skin drying. Delayed skin-drying tests on coffee from many estates shows that the potential incidence is some 30 times greater than the natural incidence and several full-scale cases of the flavour, inexplicable by the accepted "dirty water" theory, have been shown to be associated with delayed drying. The "onion" mechanism remains unknown and many samples do not develop the flavour even when subjected to gross delay in drying or to over-fermentation.

In the storage of black stage coffee for about one month, the development of brown endosperm colour is related to high temperature (85°F.) and the development of sourness and "mbuni" (dried in the cherry) flavour to absence of ventilation. The ventilation rate required to prevent off-flavour development is small: about one air change in two to three days.

In the storage of "white stage" coffee (45% to 35%), the development of mould or off-flavours can be prevented for a considerable time by storage in bulk with forced ventilation using unheated air. The allowable storage time may be as long as a month. This finding is of great practical importance since it solves the obvious difficulty in using combined sun- and machine-drying systems during the rains.

The research has now reached a point where definite recommendations can be made to planters based on the combination of three methods:

- (a) Normal sun drying to effectively complete colour development, but for a period of about four instead of eight days;
- (b) Machine drying in any reasonable drier at temperatures not above 120°F. to complete or precede the sun-drying stage;

- (c) Storage in simple ventilated bins to carry damp coffee through periods of rain and for final conditioning when required and when possible.

These methods are now being widely adopted and supervision of the work at estate level has been passed to the Coffee Processing Officer of the Coffee Research Station, Jacaranda. The tenth technical report has been published and a full summary of the work published in the Bulletin of the Coffee Board of Kenya.

COFFEE-GROWING IN AFRICAN AREAS

In 1958 there was accelerated coffee development in many African districts. For the first time coffee produced by African growers in Central Province during one crop year exceeded £1,000,000 in value. The total 1958/59 African coffee crop of 3,641 tons was worth approximately £1,500,000. Between June, 1957, and June, 1958, the number of licensed African coffee-growers increased from 57,210 to 83,752. During the same period the total African coffee acreage rose from 15,272 to 23,146 acres.

The services of the Agricultural Officer (African Areas) were required constantly by Field Officers of the Agricultural Department; special problems were referred back to the Coffee Team at Jacaranda. Frequent visits were made by Mr. Hanger to all coffee-growing districts in the Central, Nyanza and Southern Provinces. The Laitokitok, Teita, Baringo, Nandi and West Suk districts were also toured to assess the prospects for African coffee-growing in these areas.

African Coffee Development

New plantings of coffee are proceeding at a rate in excess of 5,000 acres per year. It should be stressed, however, that coffee plantings are being carefully controlled and integrated with a policy of planned farming in the African land units. In the ecological zone where coffee is known to thrive the main cash crop on most African holdings will be coffee, but on many farms coffee is only one of several cash crops grown by the farmer. The general standards of culture of African coffee remain high and gradually a sound knowledge of coffee-growing is being acquired by the growers. There is now a general realization by farmers in the older African coffee-growing districts of the need for proper pruning, mulching, weeding and manuring.

The quality of African coffee continues to be good and although the total crop has increased rapidly quality standards have not deteriorated.

AFRICAN COFFEE PRODUCTION

TABLE LVII

	<i>Crop year 1955/56</i>	<i>Crop year 1956/57</i>	<i>Crop year 1957/58</i>	<i>Crop year 1958/59</i>
Total Kenya crop	23,919 tons	18,472 tons	20,837 tons	23,356 tons
Total African coffee crop	781 tons	1,521 tons	2,047 tons	3,651 tons
Percentage of total Kenya crop in first three classes	12.69%	20.94%	20.84%	25.02%
Percentage of African production in first three classes	52%	48%	52%	52%
African coffee production as percentage of the total Kenya crop	3.3%	8.2%	9.8%	15.5%

The management committees of Coffee Co-operative Societies now appreciate the necessity to provide coffee of highest quality in the factories and some societies pay a bonus to factory employees based on the out-turn reports received from the Coffee Marketing Board. Several African Co-operative Societies have already achieved a reputation for coffee of excellent quality amongst coffee buyers at the Nairobi auctions.

Factory Development

As the acreage of coffee in bearing increases there is a need for extensions to be made to old coffee factories and the erection of factories to serve new areas is frequently necessary. Factory design is based primarily upon the supply of water available at the factory site. In areas where water

is plentiful a factory with siphon feed, rotatory screen and pre-washing channels is erected, but where water is in short supply a factory with dry feed, Aagaard sieve and without pre-washing channels is built. All new factories are designed to allow for easy extension of every part of the factory when the crop increases.

In many areas of Central Province difficulty is experienced with the drying of coffee in the cool, cloudy weather which follows the main Rains in June and July and August. To overcome this problem a large number of coffee-drying bins are being installed to accommodate coffee when sun drying on open tables is impossible. Various other coffee driers are also being built to permit the maximum use of the often limited amount of sunshine.

Variety Trials

In 1958 much valuable information, mostly of an observational nature, was collected from the coffee variety trials in African areas. The trials are not recorded for yield unless it is considered that valuable information is likely to accrue.

Above 5,000 ft. in Meru and Embu districts the varieties S.L.28 and S.L.34 continued to produce excellent crops of good quality coffee. The variety Meru Kents is being superseded by S.L.28 and S.L.34 in both districts.

In Fort Hall the variety S.L.6 continued to show resistance to Leaf Rust and will be planted commercially as an alternative variety to K.7 in the Leaf Rust (*Hemileia vastatrix*) endemic zones of Central and Nyanza Provinces. The performance of K.7 in Elgon Nyanza was outstanding when compared with S.L.2, S.L.14, S.L.28, S.L.34 and Kapretwa Series A. In Nyanza Province below 5,400 ft. the chief limiting factor to production was Leaf Rust.

Preliminary results from the Rust exposure trials planted in 1956 indicate that the Indian varieties S.288 and S.795 are immune to Races I and II of *Hemileia vastatrix*; information on crop potential and liquoring quality should be obtained during 1959.

The yields produced by the variety Blue Mountain in the Central and Southern Provinces have been disappointingly low; the trees are not vigorous and do not like dry periods or cold night temperatures. In exposed conditions the best resistance to "Hot and Cold" was shown by the variety S.L.34.

Robusta Coffee-growing

Following the successful outcome of *Coffea canephora* trials in Nyanza Province, it was decided to introduce limited commercial development of Robusta coffee in parts of Elgon, North and Central Nyanza districts. In November, 1958, Mr. Hanger visited Uganda on a study tour of *Coffea canephora*. This was followed immediately by a safari to most of the potential Robusta coffee areas in Nyanza Province.

RUKERA DEMONSTRATION FARM

Development

When the farm was purchased in January, 1949, a programme of development was projected which was divisible into three phases. The first, an intensive phase, was envisaged as the period of major development and capital improvement in terms of buildings, equipment and farm planning. At the end of four to five years, when the major alterations had been effected, a further phase of development over a similar period was planned; during this time the basis on which the farm was designed to operate would be consolidated. After eight to ten years the ultimate aim of a long-term plan for improvement in production would then begin.

These phases have been largely followed. In the first phase, ending in 1952/53, most of the permanent buildings were constructed, essential equipment purchased and the major alterations in farm policy were put into effect. Development in the ensuing phase has comprised construction and installation, generally of an ancillary nature, agricultural development, including further fencing, completion of the coffee planting programme, extending mulch production, bringing the remaining acreage into production, etc.

The long-range policy includes the replanting of all the established coffee over a period of 20 years, using selections which variety trials on Jacaranda indicate are the most suitable for the conditions.

During the year under review, consequently, the capital improvements required in respect of buildings were of a minor nature: a lean-to shed for drying coffee seed and an artificial insemination room added to the dairy were built.

Farm machinery was augmented by the addition of a Ferguson diesel 35 vineyard tractor and steel trailer, a Master sprayer and EMC 50 Coffee Rotavator. The Fiat crawler tractor was transferred to Jacaranda. A small portable pump and pipes were purchased for irrigation of riverine paddocks.

Field developments were as follows: a new area of bench terraces was planted with 200 Cape Naartjies, the coffee nursery was extended and a further area of six acres prepared for contour planted coffee.

1958-59 Crop

Rainfall: 1.1.58 to 31.12.58	54.23
Acreage in production	87.4
Clean coffee (tons)	24.45
Average per acre (cwt.)	5.61
Mbuni (lb.)	3,186

Classification	lb.	Percentage
Class 2	8,223	16.25
" 3	19,977	39.48
" 4	3,556	7.03
" 5	5,687	11.24
" 6	3,761	7.43
" 7	1,115	2.20
" 8	1,492	2.95
" 9	1,737	3.43
" 10	1,955	3.86
" 11	2,905	5.74
" 13	198	0.39
	50,606 lb.	100%

6,196 lb. of parchment were prepared as coffee seed from two clonal blocks of S.L.28 and S.L.34. A clean coffee allowance for this has been added to the total weight of crop shown above.

The average basic scale price of the crop was 102.37 cents per lb. without bonus. The estate's entries won first prize in the Grade A and All Grades classes at the R.A.S.K. show in October.

Other Enterprises

The process of herd improvement was continued, culled beasts were sold and three in-calf heifers were purchased. The milk yields are steadily improving, albeit slowly, as a result of better-grade animals in the herd.

Between February and December 11,500 lb. of Washington Navel Oranges were picked from the two acres of trees, realizing an average price of 18 cents per lb.

Farm Accounts

A general description of the farm was included in the 1956/57 edition of this report. Among the original aims defined, as stated in the Coffee Board Bulletin of January, 1953, it was considered that cost accounts were an essential feature of the farm's functions, namely, in the following statement:—

“As the farm will be self-accounting costings will be fully valid. It is the intention to have the farm accounts supervised by professional farm accountants and accounts will be kept and presented in the same manner as is adopted on the best local estates.”

An application to put the farm on a self-accounting basis was refused, unfortunately, after prolonged negotiation and the employment of professional farm accountants was later deemed an unnecessary expense.

As from the 1st July, 1956, detailed accounts were maintained under the guidance of the Executive Officer of the Coffee Board, who undertook to analyse the data and produce therefrom an annual balance sheet, profit and loss account, enterprise trading account, cost account and an annual capital valuation.

During the latter half of 1958 a firm of professional accountants was engaged to attempt to extract the information required from the records of ten years and in particular from those of the previous two years.

Schedules relating to capital expenditure, annual income and expenditure which have been computed are shown on the next page.

From the details supplied to them the accountants were able to draw up a balance sheet, profit and loss account, trading account and a schedule of fixed assets, for the two years 1956/57 and 1957/58. Whilst these accounts are of considerable interest their complete accuracy in every detail cannot be guaranteed. In the absence of professional guidance while the records were being taken some essential supporting evidence was incomplete and the accountants were unable to check the monthly costing sheets as they were compiled and suggest appropriate amendments.

For the highly specialized purpose intended the volume of information which must be accumulated is considerable, to allow correct interpretation of the figures obtained. Consequently those responsible for analysing the accounts consider that it would be misleading to publish the summaries without full explanation and qualification. Since the volume of the latter is considerable it has been decided not to publish the figures until at least a further year's figures are available. The latter will entail, for example, a detailed analysis of the Farm Manager's time spent annually on each enterprise. To compute accurately the cost of all farming operations very detailed records are necessary and this has been arranged during the current period, ending at the 30th June, 1959. It is regrettable that the fulfilment of this crucial function of the farm has been so long delayed by circumstances imposed from without.

CAPITAL EXPENDITURE

1949-1958

Year to 30th June	1949*	1950	1951	1952	1953†	1954†	1955	1956	1957	1958
	£	£	£	£	£	£	£	£	£	£
Original investment	9,024									
Additions		1,903	5,531	4,672	4,155	1,118	1,374	335	1,370	189
Less: Sales and Depreciation	113	108	581	473	967	668	624	527	574	616
	-113	1,795	4,950	4,199	3,188	450	750	-192	796	-427
Cumulative Balance	8,911	10,706	15,656	19,855	23,043	23,493	24,243	24,051	24,847	24,420

INCOME AND EXPENDITURE SUMMARY

1949-1958

Proceeds from Sale of Produce, etc.	734	3,018	4,270	8,651	23,921	65	9,937	15,797	16,613	19,004
General Expenditure (including Sales and depreciation as above)	2,006	2,033	3,002	3,669	8,606	2,713	6,830	9,136	8,631	8,965
Net Profit		985	1,268	4,982	14,685		3,107	6,661	7,982	10,039
Net Loss	1,272					2,648				49,709
Cumulative Balance	-1,272	-287	981	5,963	20,648	18,000	21,107	27,768	35,750	45,789
Coffee crop: clean—tons	Nil	9.1	1.25	29.42	23.0	33.16	18.56	36.96	25.33	29.65
Mbuni—lb.	Nil	55,764	1,080	11,421	14,969	7,776	10,785	3,692	16,013	37,851
Coffee seed—lb.	Nil	Nil	Nil	Nil	Nil	138	2,016	2,071	1,336	2,590

*It should be noted that the date of purchase was 1st January, 1949, and that in the 1948/49 year the crop was not included in the purchase price.

†The peculiar nature of the figures in these two years is accountable by the financial year being altered from the calendar year to the period 1st July-30th June. The accounts should be aggregated for a true reflection of the position during these two years.

FIXED ASSETS—VALUATION

	1st July 1948 £	30th June 1949 £	1950 £	1951 £	1952 £	1953 £	1954 £	1955 £	1956 £	1957 £	1958 £
Land 250 acres	8,663	8,663	8,663	8,663	8,663	8,663	8,663	8,663	8,663	8,663	8,663
Development			862	2,235	3,186	4,431	4,621	4,621	4,621	4,621	4,621
BUILDINGS											
Additions less depreciation											
Coffee					860	1,984	1,944	1,905	1,867	2,018	2,054
Cattle and Dairy				1,067	1,046	1,025	1,247	1,409	1,576	1,672	1,639
Estate and Farm	253	248	788	1,220	3,647	3,599	3,972	4,530	4,571	4,613	4,511
Labour lines	108	—	—	—	—	—	—	—	—	—	—
FENCING											
Additions less depreciation			164	139	119	101	162	422	358	344	358
PLANT AND MACHINERY											
Additions less depreciation				675	672	680	658	637	618	1,135	1,043
PLOUGHS AND TRACTORS											
Less depreciation			56	506	354	1,066	746	522	366	256	179
MOTOR VEHICLES											
Additions less depreciation			153	105	74	191	134	94	66	46	32
Water supply				863	1,054	1,145	1,118	1,147	1,088	1,032	979
IMPLEMENTS AND SUNDRIES											
Additions less depreciation			20	183	180	158	228	293	257	447	341
	9,024	8,911	10,706	15,656	19,855	23,043	23,493	24,243	24,051	24,847	24,420

SUBSTATIONS

Although the results obtained from field trials at the Coffee Research Station are directly applicable to a large and productive area East of the Rift Valley, wherever conditions differ in appreciable degree from those at Ruiru the treatments cannot be introduced into local practice until they have been tested locally.

It is now accepted that the complexity of long-term experiments requires the facilities and supervision of a substation. Three such substations, which were not closed during and immediately after the war, have been running for many years, viz.: the coffee plots on the Experimental Station, Kitale, at the Scott Agricultural Laboratories, Kabete, and at North Kitito Estate, Makuyu. Unlike Kitale, the other two stations have no resident Coffee Officer in charge of the trials but are operated directly from Ruiru.

In order to extend the range of conditions covered by substations it has been the policy during the past three years to extend the number of substations by the four which are briefly described hereunder. The experimental results from all substations are included in the chapter on Field Investigations.

Kitale Experimental Station

1958-59 Crop

Rainfall :	1.1.58 to 31.12.58 (inches)	57.35
Acreage in production		14.00
Clean coffee (tons)		2.1
Mbuni (lb.)		1,508
<i>Classification</i>	<i>lb.</i>	<i>Percentage</i>
Class 3	2,701	57½
„ 5	634	13½
„ 6	104	2¼
„ 7	142	3
„ 8	36	1
„ 9	199	4½
„ 10	149	3
„ 11	639	13½
„ 12	8	—
„ 13	86	2
	4,698 lb.	100%

In addition to the above, experimental samples amounting to one-tenth of the crop from two acres were extracted and 950 lb. of seed were produced from the bearing acreage.

The year's rainfall was over ten inches above average and well distributed, but the effects were not wholly beneficial: Leaf Rust infection was exceptionally heavy, despite prophylactic pre-Rains copper spray. The yield was below the average of recent years due to Rust and a severe hailstorm in June, which induced an abnormal level of Coffee Berry Disease in some blocks.

The classifications shown above are based upon bulk milling with other estates' crops and therefore the quality of the season's crop cannot be accurately assessed.

Development

The prevailing revival of interest in coffee-growing in the district and its undoubted value in a mixed farming economy necessitates an expansion of the range of coffee experiments. Consequently the policy has been to develop the resources of the station to enable the full experimental potential to be attained.

Towards this end the new nursery, with a capacity of 8,500 seedlings, was completed. Three acres of heterogeneous coffee were uprooted and prepared for replanting. New water pipes were

laid to central points in the coffee and boundary fences erected. Plans for improving the factory, drying ground and stores could not be put into effect before the end of the period, however.

Mount Elgon Trials

Following discussions with local planters a generous offer by Mr. H. D. Collie for experimental facilities on his estate was accepted: three trials were designed and laid down on young coffee. These are aimed to investigate some of the outstanding cultural problems peculiar to the conditions on the mountain.

Upper Kiambu Substation

Development of the station has progressed satisfactorily during the year. Permanent buildings, comprising an office, sample room and store, two houses for Field Assistants and labour quarters have been constructed. A borehole had to be drilled because surface water was not available. Unfortunately, and contrary to expectation, it was necessary to penetrate to 700 feet to reach a satisfactory supply.

The ten-acre plot of mature coffee, leased from Yara Estate, was taken over in February 1959. A proposed experimental programme was discussed with local planters at a meeting on the station during November. The plans were adopted and preparations for field treatments were completed before the Long Rains.

Nyanza Substation

The Board's decision to provide funds for an expanded research and advisory service in Nyanza was implemented when Mr. Toomey was transferred from the Field Services Division of the Agricultural Department in August. In December the Board decided to purchase Khitari Farm in Koru. Since January, when the farm was taken over, good progress has been made to prepare 25 acres of land for planting with K.7 seedlings during the Long Rains. Trees and bush were cleared from three acres of derelict coffee and plans were made by the management committee for the full development of the farm. The members of the committee are the Nyanza member of the Coffee Board, two of the Nyanza Coffee Delegates, the Officer-in-Charge and the Senior Research Officer.

Meru Substation

Coffee investigation stations in Meru and South Nyanza were proposed in the Swynnerton Plan. Their specific object was that of research into problems of coffee-growing in the regions adjacent to Mount Kenya and in the Nyanza basin respectively. Moreover, the application of practices proven elsewhere (e.g., Ruiru) requires study under the environment typical of the two regions.

An area of some 57 acres at Mariene was acquired in 1957. The station is situated at 5,200 feet and under conditions of soil and climate which are typical of the major portion of the coffee-growing zone of the district.

Since Mr. Wallace was posted there in 1957 excellent progress has been made in developing the station. The usual range of buildings has been erected and water supply installed. Field work has included bush and tree clearing, a ring fence, roadways, seedling nursery, bench terracing. Grass plots, shelter belts and mulch grass areas have been planted.

Kisii Substation

The station was inaugurated a year earlier than Mariene and is therefore more advanced in its development. Situated at 5,600 feet, a total area of approximately 34 acres was acquired from the Experimental Farm and the Education Department in January, 1957. Progress in development included completion of office, sample room and store, a ring fence and internal roadways. In the field the emphasis was on planting: 11 acres of Blue Mountain seedlings were planted and a similar acreage prepared for planting during 1959. Difficulty was experienced in achieving effective soil conservation measures in the newly planted coffee (due to the nature of the soil, the slopes and the need for retaining uniformity). The problems were resolved after a complete plane-table survey and with the assistance of Mr. Brook (Officer i/c, Soil Conservation Service Headquarters, Ruiru) satisfactory measures for the dispersal of run-off water were devised.

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